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Railways, Electric Railways, Elevated and Cable Railways, Horse and Motor Railways, Highways, Bridges, Tunnels and Canals, Water-Works, Irrigation, Sewers, Streets, Electrical, Contract Prices, Miscellaneous, Manufacturing and Technical, Current Price List.

A novel variable speed gearing was described in a recent discussion before the Institute of Electrical Engineers by Mr. Chas. E. Emery. As applied to a street car, the motor on the car was made to operate a pump of variable capacity. The discharge pipe from this pump led to a hydraulic motor fixed on the car axle, and the discharge from the motor was piped back to the pump suction. The idea of such a combination having occurred to Mr. Emery, he concluded first of all to test its novelty by putting an application into the Patent Office, drawn broad enough to cover the general idea. This disclosed the fact that there had been dozens of applications before the Office, that the general principle had been well covered by patents years ago, and that several interferences were pending with parties who proposed to use modifications of the system. One man had actually made use of the system, and had applied the apparatus to a street car. The difficulty found in the operation was that the fluid soon became so highly heated that it was necessary to stop running and allow it to cool off. If this difficulty could be overcome, as seems possible, the device might be of considerable value.

Two fast long distance runs with the Empire State express on the New York Central & Hudson River R. R. are reported. In one instance it ran 115.75 miles in 110 mins., 51.67 miles being made in 46 mins., or at the rate of 67.38 miles per hour. In the second case the train made 101 miles in 96 mins., 28.43 miles being made in 25 mins., or at the average rate of 68.23 miles per hour. In each case the train consisted of four cars and was hauled by an eight-wheel engine, with driving wheels 6 ft. 6 ins. diameter.

Ten of the new cars equipped with the Waddell-Entz storage battery system will begin running on the Second Ave. line, New York city, between 127th St. and 70th St., this month. These are the first of the cars with which the entire line is to be equipped as rapidly as possible. The cars are 16 ft. long and unusually elaborate. They will be finely finished inside, have a protected platform and folding gates, and are lighted with electricity. The lights are to be provided with an auxiliary set of batteries, so that there can be no fluctuations in the light with changes of grade or speed. The spaces beneath the seats are adapted for holding the batteries, and there will be hinged panels in the ends of the car, and a dashboard, in order that the battery trays may be removed. The cars have improved trucks and wheels. The total weight of equipment is not greater than that of the standard trolley cars of the same size.

The Silvey storage battery system of train lighting, which is being put on the market by the Dayton Manufacturing Co., of Dayton, O., has been in use for nearly a year on the Chesapeake & Ohio and Atchison, Topeka & Santa Fe trains, with, it is claimed, very good success. The storage battery in train lighting has generally proved an expensive and obnoxious nuisance; but it is claimed that the Silvey battery is a great improvement on its predecessors, as respects durability, reliability and freedom from nuisance. It is claimed that 12 cells, weighing 950 lbs., will light a car for three nights, furnishing 144 c. p. The first cost of equipment per car, including the proportion of cost of fixed plant, is given by the makers as $402, allowing one charging plant for each 50 cars. The cost of operation per annum, including interest and depreciation on original investment, is given at $120.90 per car, which is certainly a much lower figure than any other system of electric train lighting has thus far been able to show in service, although it is somewhat higher than the cost of an equal amount of light from mineral sperm oil or Pintsch gas. See Engineering News, March 19, 1892.

The most serious railway accident of the week was a head collision, which occurred Dec. 28 on the Chicago, Rock Island & Pacific R. R., three miles east of Troy, Kan. The colliding trains were the east-bound Denver express and a through freight. The conductor and engineman of the freight did not correctly read their running orders received at St. Joseph. The baggageman on the express was killed and eleven persons were injured.—A serious grade crossing collision occurred in Chicago on the morning of Dec. 29. A locomotive running backward at about 15 miles per hour struck a crowded horse car, killing four of its passengers and seriously injuring ten. The coroner's jury lay the blame to the two flagmen at the crossing, the conductor of the street car and the engineman of the locomotive—a verdict quite justifiable as respects the flagman and perhaps the conductor, but apparently an undeserved reflection on the engineman.

A dynamite explosion occurred in Long Island City on Dec. 28, at the mouth of the shaft from which the New York & Long Island Tunnel Co. is carrying on its work of excavating a tunnel under the East River. The explosion was caused by thawing frozen dynamite in a chamber heated by steam pipes. The chamber was a wooden box about 6 ft. square and 8 ft. high, containing a coil of steam pipe, and having shelves on the sides on which the boxes of frozen dynamite cartridges were placed. The mouth of the shaft is in the midst of a thickly populated tenement district, and 4 persons were killed and about 20 seriously injured by the explosion. Unfreezable dynamite is manufactured in Europe, and it is reported that steps will be taken to introduce the material into this country.

The compulsory use of water-meters, and a maximum rate of 50 cts. per 1,000 gallons, will be required in all Kentucky cities of the second to fifth classes, inclusive, if a bill recently introduced in the legislature of that state becomes a law. The measure applies equally to water-works under private and public ownership.

A North River ferry boat ran into its slip at full speed on Dec. 26, owing to the failure of its engines to reverse. The boat was the "Fanwood" of the Central Railroad of New Jersey line, equipped with the old-fashioned walking beam engine. The ferry bridge was pushed against the ferry house platform, which was shoved about 1 ft. eastward, and part of the roof columns, which rested on the platform, had their feet knocked out of position. It speaks volumes for the strength of the ferry boat's hull and guard timbers that she suffered practically no damage by the collision, and was put in service after examination. The cause of the accident was found to be the dropping out of a split cotter which secured a pin connection at the bottom of the drop rod from the reversing lever. The pin soon fell out and the engineer was then powerless to back the engine at the call of the pilot. A similar accident occurred on a boat of the Cortlandt St. ferry of the Pennsylvania line nearly a score of years ago.

Two St. Louis men have concluded that the Interstate Commerce law is not a dead letter. They have been sentenced to 18 months' imprisonment and $2,000 fine for bribing weighers and switchmen in a railway company's employ in order to secure low rates on lumber shipments.

Some interesting figures of the cost of tin plate manufacture in Wales are given by the "Iron Age." The various items entering into the actual cost of a 100-lb. box are as follows:

	Price per ton.	Cost per box.
Black plates	$37.71	$1.835
Tin	456.00	.546
Palm oil	59.35	.027
White vitriol	19.04	.029
Coal	1.34	.040
Elm boxes		.0.90
Tinning labor		.240
Salaries and charges		.016
Stores, castings, rents, rates and taxes		.053
Commissions, interest and bank charges		.042
Cost of finished plates		$2.888

It is evident that the chief reliance of the American manufacturer in attempting to compete on equal terms with his foreign rival must be on a reduction of the cost of the black plate. The bars from which the black plate was rolled in the mill whose expense account is reported above, cost net, $22.68 per ton (ordinary steel bars being at the time worth less than $20 per ton in the market). This leaves $15.03 as the cost per tons of making black plate; and as the American manufacturer has to pay $5 to $7 more per ton for his steel bars, the Welsh methods will have to be materially improved upon in order to bring the cost of black plate to a lower figure.

The Madison Ave. bridge, across the Harlem River, in New York city, was recently closed to traffic by an unusual cause. The bridge roadway is paved with rectangular wood blocks on a concrete base. During the recent cold weather sufficient ice formed in the spaces between the blocks to exert great side pressure, and, as the bridge floor system held the curbs from spreading, the paving blocks rose at the crown. At the same time the approach span at one end of the draw span was moved longitudinally by this or some other cause sufficiently to prevent the draw span from opening.

The water-works intake pipe at Toronto rose from the bed of the bay a few days ago and broke through the ice at several points, parting or opening at some of the joints. It is said that the flow of water through the pipe was so obstructed as to cause it to become empty, after which it floated to the surface.

The great iron tower plated with aluminum on the Philadelphia City Hall, built by the Tacony Iron & Metal Co., has cost the city all told $533,602. The plant used for the aluminum plating process cost $23,525, and the cost of material for and running expenses of the aluminum plating amounted to $32,480. The aluminum plating process was described in our issue of June 16, 1892, p. 597.

A great electric power transmission scheme is being discussed in England. Mr. B. H. Thwaite, the originator of the scheme, proposes to burn coal at the pit's mouth for the generation of power, and transmit this power electrically to the principal cities and manufacturing centers of England. The power would be generated by gas engines consuming only ¾ to 1 lb. of coal per horse-power-hour, and the residual products of the coal would all be saved and shipped by short haul to the agricultural districts, where they find their chief use as fertilizers. The cost of small installations of motive power (below 20 HP.) in London is said to be from $50 to $90 per horse-power per annum. Mr. Thwaite claims that electrical energy can be generated in the South Yorkshire coal fields and transmitted to London, a distance of 160 miles, at a cost of only $22 to $25 per horse-power for 3,000 working hours per annum.

THE PECOS VIADUCT.
(With inset.)

Beginning with the earliest forms of timber trestles, a type of railway bridge has been gradually developed whose peculiarity to this country has given it the name of the American railway viaduct—a bridge of wood or metal in which the different spans are supported directly upon legs or towers composed of two or more trestle bents braced together in all directions. This evolution reached its present point of practical uniformity of design in 1875 to 1878, its distinguishing feature being the use of only two bents of two main posts each, braced together in all directions, whatever the height of the tower, instead of a group of bents with continuous lines of diagonal rods from the top of the first to the foot of the last bent in the group, thus making the number of bents in any particular group dependent on the height of the tower. A great number of small viaducts were built prior to 1882 after this improved method, but its first application to a bridge of any very great magnitude was in the Kinzua Viaduct, which is well known for the boldness of its design and its embodiment of the distinctive features of this type of viaduct construction. This was built in 1882, and is located at the crossing of Kinzua Creek, which flows through a gorge some 300 ft. below the level of the surrounding country, on the New York, Lake Erie & Western R. R., in McKean Co., Pa. The longest bent in the towers of this structure is 279 ft. between the top of the masonry and the top of the tower, and is divided into 10 stories. The legs of the bent are the well-known Phoenix columns connected at each story by horizontal struts of latticed girders and braced by ⅞-in. rods.

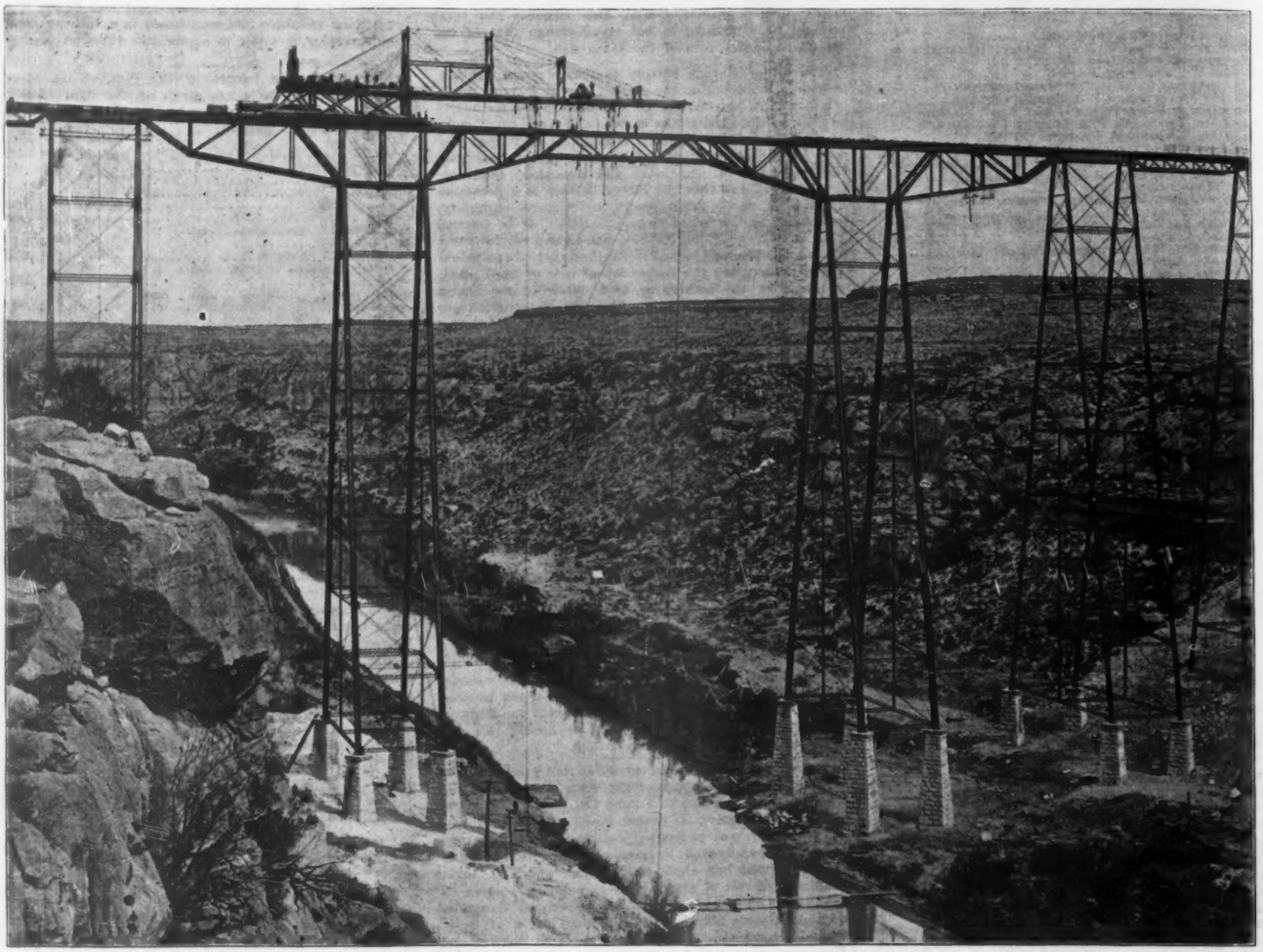
Some years later the general plan of the Kinzua Viaduct was closely copied by English engineers in the construction of the Loa Viaduct on the Antofagasta Ry., in Bolivia (Eng. News, May 18, 1889.) This viaduct spans the canyon of the river Loa in the upper Andes at an elevation of 10,000 ft. above the sea level, and if counted from the surface of the water to the top of the rails is the highest in the world, if we except the St. Giustina Bridge in the Tyrol, and the Garabit Bridge, in France, which are merely iron arches over deep gorges and have piers or towers of no great height. The length of the longest bent of the Loa Viaduct is 314 ft. 2 ins., and its legs are of the Phoenix column type.

We now illustrate a third, and in some respects a more important viaduct, on our inset sheet and in the accompanying cuts. These three bridges are in all respects typical examples on a large scale of the American railway viaduct. A comparison of their principal dimensions is given in the accompanying table:

	Kinzua.	Loa.	Pecos.
	Ft. Ins.	Ft. Ins.	Ft. Ins.
Total length	2,050	800	2,180
Height above surface of water	302	336	320 10¾
Length of longest bent	279	314 2	241 0¾
Width of towers, c. to c. of bents	38 6	32	35
Longest span	61	80	185
Width over all	18	13	16
Width c. to c. of trusses	10	8 10	10
Gage of railway	4 8½	3 6	4 8½
Weight of iron work	1,400 tons	1,115 tons	1,820 tons
Batter of posts	1 in 6	1 in 6	1 in 6

The general design of the Pecos Viaduct is shown in the accompanying photographic view, and the plan and elevation on the inset sheet. It is a part of the long projected improvements of the Southern Pacific Co., to avoid the heavy operating and maintenance expenses of its Galveston, Harrisburg & San Antonio line through the canyons of the Rio Grande River, between Shumla and Helmet stations in Val Verde County, Tex. The distance between Shumla and Helmet by the old line is 24½ miles, and owing to the heavy grades and extremely heavy curves the line is very difficult to operate. The larger part of this distance is taken up in the development of the line to get from the general level of the country down into the canyon of the Rio Grande in order to cross the Pecos River at its mouth at ordinary high water, and in developing out of the canyon after having made the crossing. From the point where the line strikes the Rio Grande River to where it leaves it, the roadbed is located on a shelf blasted out of the nearly perpendicular walls of the canyon, which rise above the track to a height of over 250 or 300 ft. The canyon walls being composed of a soft limestone rock, full of seams and fissures, almost every heavy rain causes slides of rock, which lodge on the track and necessitate a force of day and night watchmen to patrol the track to guard against accident. The speed of trains is also limited as an additional precaution.

Shortly after the completion of the line a survey was made by Maj. James Conners, then chief engineer of the Galveston, Harrisburg & San Antonio Ry., leaving the main line a short distance east of Flanders and rejoining it at Shumla. The con-



PECOS RIVER VIADUCT; GALVESTON, HARRISBURG & SAN ANTONIO RY.; J. Kruttschnitt, Engineer; A Bonzano, Engineer, Phœnix Bridge Co

struction of a line over this route necessitated, however, a very heavy cut or tunnel at the summit of a divide that had to be crossed between the main line and the Pecos River, besides the construction of a viaduct about 150 ft. high, and 900 ft. long over a canyon just south of the main canyon of the Pecos River. In 1889 and 1890 the country was carefully re-examined, and while the old location of Maj. Conners, north of the Pecos River, was followed in the main, the location from the river to the junction with the main line was materially changed, and although a greater mileage had to be constructed, its cost was about the same as that of the proposed Connors line. The locating surveys for the revised line were made in 1890 by Mr. B. M. Temple, who, for a large part of the distance, found a natural ridge on which the road could be built with very light work. This ridge, which is clearly shown on the accompanying map, is so well defined and so narrow that for nearly four miles there is no opening or culvert through the roadbed.

MAP OF PECOS CUT-OFF; GALVESTON, HARRISBURG & SAN ANTONIO RY.

The maximum curve on the new line is 4°, and the ruling grades are 0.8 of 1%, except at the west end of the viaduct, where there is a short curve of 5°, and at the east end of the viaduct, where there is one grade of 1%. The length of the old line was 24½ miles, and the length of the new line is 13.3 miles, making a saving of 11.2 miles in distance. In addition, 378 ft. in rise and fall in grade and 1,933° in curvature were saved by the construction of the new line. The numerous side canyons on the old line are crossed on high trestles or iron bridges. This required 14 iron spans, aggregating 2,730 ft. in length and weighing 3,893,000 lbs., or more than the total weight of metal (3,640,000 lbs.) in the Pecos Viaduct, and 3,600 ft. of wooden trestlework. On the new line there are 600 ft. of trestle, all built of creosoted pine lumber. The smaller openings are vitrified pipe with brick masonry face walls.

The chief feature of engineering interest on the line is of course the viaduct over the canyon of the Pecos River. This viaduct is 2,180 ft. long between abutment walls and is composed of plate and lattice girders resting on steel towers. There are 34 tower plate girder spans each 35 ft. long; one plate girder span 54 ft. long; eight latticed spans 65 ft. long; two cantilevers 102 ft. 6 ins. long each; two cantilevers 70 ft. long each, and one suspended span 80 ft. long. The height from the base of the rails to the surface of the water is 320 ft. 10¾ ins., and to the bed of the river is 330 ft. The composition of these various spans presents nothing unusual, and is quite well shown in the general elevation and plan, on the inset sheet.

The supporting towers are 23 in number, and, with the exception of the two supporting the cantilevers, which are illustrated in detail, are built of steel Z-bars. All of the towers rest on cut stone piers, most of which are but a few feet in height, the bedrock being very near the surface. In the bottom of the gorge, however, it was necessary to build the piers to a considerable height in order to keep the metal work entirely above the line of possible flood. To get foundations for these piers excavations had to be carried down through the boulders and debris to bedrock, which for some of the piers was from 30 ft. to 40 ft. below the surface of the ground. Piers Nos. 11 to 17, inclusive, are built of compact white limestone quarried near the site of the bridge and are 7 ft. square under the coping. The coping stones, two in number for each pier, are syenitic granite from the quarries in Burnet County, Tex., that furnished the stone for the Texas State Capitol, and are uniformly 20 ins. thick. The anchorages for the tower feet carrying the cantilevers and the shore arms of the cantilevers were built into the piers, but for the other towers the anchor bolts were set in Portland cement mortar after the completion of the piers. The work of locating the piers was in charge of Mr. W. F. Kendall, Assistant Resident Engineer.

Details of bents Nos. 13, 14, 15 and 16 composing the two towers supporting the cantilevers are shown in the inset sheet. Unlike the other towers, these are made up of plates and angles instead of Z-bars. It will be noticed that the use of the Phoenix column, which formed the tower legs in both the Kinzua and Loa viaducts, has been abandoned in this structure. Each bent is composed of two inclined legs, with a batter of 1 to 6, connected with each other and also with the posts of the vertical truss connecting the lower part of the two bents forming the tower, by horizontal and inclined struts and diagonal bracing. Each tower is composed of two bents placed 35 ft. apart c. to c. and connected by horizontal struts, and at the lower part by the vertical truss before mentioned. The horizontal struts divide the tower into eight stories, one 30 ft. 10⅞ ins. high and seven 30 ft. high each. The composition and dimensions of the various members and the general arrangement of the bracing are fully given in the illustrations. Details of the pedestals and tops of the columns, or tower legs, connecting with the cantilevers and the connection of the lattice and plate girder spans, are also shown in separate drawings.

In a structure of the height of the Pecos Viaduct the question of wind pressure is of course a very important one. For the Kinzua Viaduct it was considered that a pressure of 50 lbs. per sq. ft. should be provided for when the structure was unloaded, but that when the bridge was loaded from end to end by a freight train a pressure of 30 lbs. per sq. ft., including the area of the train, would be large enough, as this would blow the train off the bridge. The dead load was taken at 1,000 lbs per lin, ft., and the live load provided for was a consolidation engine and tender 54 ft. 3 ins. long over all, weighing 161,340 lbs., with 88,000 lbs. on drivers, and a driving wheel base of 14 ft. 9 ins., followed by a uniform load of 3,000 lbs. per lin. ft. In the Pecos Viaduct the wind pressure was taken to be the same as for the Kinzua Viaduct, viz.: 50 lbs. per sq. ft. for the structure unloaded, and 30 lbs. per sq. ft. for the structure loaded. The live load taken was that provided for by the standard specifications of the Southern Pacific Co. The dead load was taken as follows:

	Lbs. per lin. ft.
80-ft. suspended span	1,200
35-ft. plate girder spans	800
65-ft. lattice spans	900
85-ft. cantilevers	1,600
52½-ft. cantilevers	1,600

The erection of the viaduct was in charge of the Phoenix Bridge Co., and was carried on without the use of false works. The work began with a small force of men on Nov. 3, 1891, and the eastern half of the bridge, including the eastern cantilevers and eastern half of the suspended span, was completed Dec. 30, 1891. Of this time nine days were lost owing to a delay in receiving duplicates of members injured while in transit, and to inclement weather, making the actual time consumed in raising 1,789,580 lbs. of iron, the weight of the eastern portion of the viaduct, 44 days, or an average of 40,675 lbs. raised daily. After completing the eastern half of the suspended span, the traveler was taken apart, loaded on cars, and transported 37.8 miles to the western bank of the river. While the work of setting up the traveler at this end was in progress a small derrick traveler was used to erect the low portions of the western part of the viaduct up to the first 65-ft. lattice girder. The work on the west end of the bridge was commenced Jan. 8, 1892, and the halves of the suspended span were connected Feb. 20, 1892. Thirty days were required for raising this half of the bridge, weighing 1,850,420 lbs., or an average of 61,680 lbs. daily. This increase of the daily progress of 21,000 lbs. over that for the eastern end of the bridge was due largely to the fewer number of high towers in the west end of the viaduct and to the use of the small traveler for raising the lower parts.

The principal feature of the plant for erecting the ironwork was the traveler, which had an arm 124 ft. 6 ins. long, with a wheel base of 57 ft. The general appearance of the structure is quite well shown in the accompanying general view of the bridge. It was composed of two main trusses placed 10 ft. apart c. to c. which carried the weight of the overhanging part and rested directly over the girders of the viaduct, and two secondary trusses built in the support and placed 18 ft. apart c. to c. The height of the arm from the base of the rail was 12 ft. 10 ins., and the distance from the base of the rail to the center of the top pin in the main posts was 41 ft. 4 ins. The entire structure was built of Calcasieu clear heart pine, except the tension members and the pin plates, which were of iron. The 4-ft. space between the inside and outside trusses was filled with a counterbalance of 50,000 lbs. of rails. In addition to this counterbalance, clamps, attached to the main trusses and clamped to the top chord of the girders supporting the traveler, which were anchored to the tops of the bents by 1⅛-in. bolts, were used to prevent

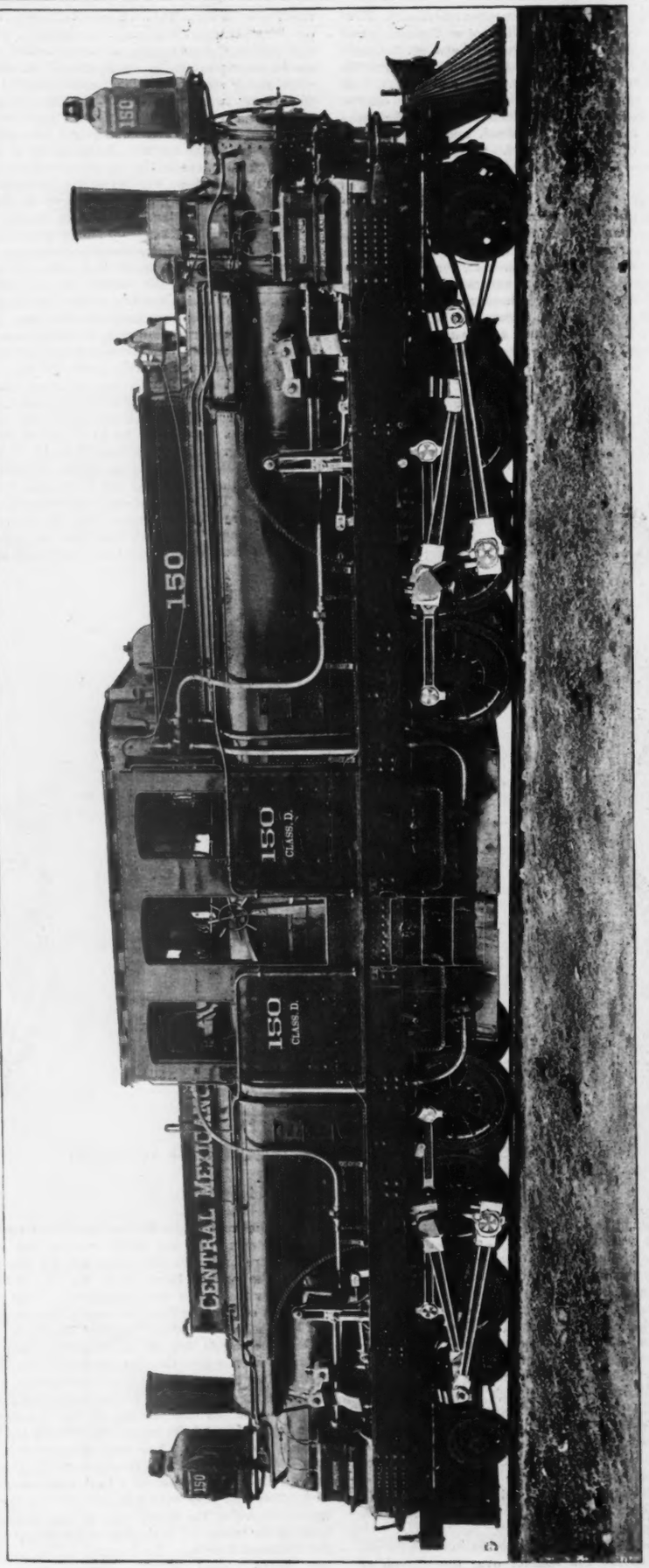
tipping. Upon the working deck there were two boilers supplying steam to two engines, each having four spools working independently. On the lower chord of the arm ran a car supporting an A-crab.

All iron was brought from the yards on push cars, raised by the crab on the traveler car, and then carried out on the arm to a point over the intended position of the member in the structure. The spreading of the main columns necessitated by the batter of the bents was accomplished by means of lines running from the sides of the traveler to points on the ground below at right angles to the bents. Some of the pieces erected weighed more than 10 tons each, and for these heavy members two falls of 16-ins. triple blocks and 1½-in. rope were used. In erecting the pairs of cantilevers the portions over the towers were erected first, and then the shore cantilevers built from the tower toward the shore. The traveler was then moved to a position over the towers and the cantilevers supporting the suspended span, and the suspended span itself, erected. To make the adjustment for connecting the halves of the suspended span, a 20-ton hydraulic jack was placed in the lower end chord-piece of the lever arm, as shown in the drawing, and made to bear against a bracket built within the chord and against the lower end of the end post of the suspended span. The end of the half of the suspended span was given a super-elevation by the jacks, and the thrust on the jacks was then taken up by filling plates placed between angle brackets on the end of the lower chord of the lever arm and cast-steel brackets on the lower end pin of the suspended span. These filling plates and cast-steel brackets were removed after making the connection. The adjustment of the top chord was made by means of two 1⅛-in. square loops fitted around the end pin of the lever arm. The nuts of these loops bore against angle brackets riveted to the stringer between the lever arm and the suspended span. These nuts were screwed up or unscrewed to make the adjustment. In making the final connection it was found that the lower chords overlapped ⅝ in., and that the top chords failed to meet. The filling plates in the lower chord were taken out and the jacks slightly slacked and the nuts of the loop bolts were unscrewed, allowing the ends to be joined.

The average number of men employed by the bridge company in erecting the bridge was 67, and 87 working days were required from the commencement of erection to the connection of the suspended span. This was a rate of 750 lin. ft. per month. For the Kinzua Viaduct the rate of erection with a force of 40 men was 500 ft. per month, and for the Loa Viaduct, with a force of 35 men, about 100 ft. per month. The designing of all details, connections, traveler, and methods of erection, as well as the work of erection, was done by the Phoenix as the work of erection, was done by the Phoenix Bridge Co., of Phoenixville, Pa., A. Bonzano, Chief Engineer, which had the man of Erection for the bridge company. The contractors for the masonry were Ricker, Lee & Co., of Galveston, Tex., who also had the contract for the grading on the cut-off. The entire work was executed under the supervision of Mr. J. Kruttschnitt, as Engineer for the Southern Pacific Co. Mr. B. M. Temple was Resident Engineer, and Mr. W. F. Kendall Assistant Resident Engineer. We are indebted to Mr. J. Kruttschnitt for the matter from which the illustrations and accompanying description have been prepared.

JOHNSTONE'S DOUBLE-TRUCK COMPOUND LOCOMOTIVE; MEXICAN CENTRAL RAILWAY.

The designs prepared by Mr. F. W. Johnstone, Superintendent of Motive Power and Machinery, Mexican Central Ry., for a double-truck, compound engine for heavy freight service on heavy grades and sharp curves, were illustrated and described in detail in our issues of March 12 and 26, and April 2 and 9, 1892. The Rhode Island Locomotive Works, Providence, R. I., were awarded the contract for three of these engines, and we illustrate this week the first engine completed, which was turned out of the shops under steam in December. We should have published this view last week, but at the request of the builders post-



DOUBLE BOILER, DOUBLE STEAM-TRUCK, COMPOUND LOCOMOTIVE; MEXICAN CENTRAL RAILWAY.
Superintendent of Machinery, F. W. Johnstone; Builders, Rhode Island Locomotive Works.

poned it until the first issue of the new year, although one of our contemporaries has disregarded this request.

As already explained, the engine has two boilers, with the fire boxes placed back to back, and the driving wheels are carried by two swiveling truck frames, one under each boiler. A two-wheel or pony truck is at each end of the engine, with radius bar pivoted to the front end of the driving truck frame. There is very little projection beyond the smokebox, which, with the small pilot, gives a stubby appearance to the engine, the object evidently being to couple up as close to the train as possible. In the Fairlie system of engines with steam trucks, the cylinders were carried on the truck frames, necessitating the use of flexible joints in the steam pipes. Mr. Johnstone, however, attaches the cylinders to the main frame, and transmits the motion of the cross-heads to the crank pins by the system of levers described in our issue of April 9. The compound system is that designed by Mr. Johnstone, and already applied to some ten-wheel engines (Eng. News, Aug. 29, 1891), which are said to give very satisfactory performance in service. These ten-wheel engines were also built by the Rhode Island Locomotive Works. There are two cylinders on each side of the frame, the high pressure inside of and concentric with the low pressure cylinder, the latter being an annular chamber or sleeve. The Mexican Central Ry. engine has four cylinders to each driving truck, or eight cylinders in all, but has one throttle valve and one reverse lever to operate both ends of the engine.

Each boiler is of 9-16-in. Otis steel, with straight barrel 4 ft. 6¼ ins. diameter, one dome 31 ins. diameter, and 201 tubes 2 ins. diameter and 15 ft. 9⅛ ins. long, with copper ferules on the fire-box end. The fire-boxes are also of Otis steel, with plates thoroughly annealed after flanging. The crown is supported by 1-in. stay bolts. The grates are of cast-iron, and the ash-pan dampers are at the side. The fuel will be bituminous coal. The valve motion is of Mr. Johnstone's design (Eng. News, April 9.) The driving wheels have cast iron centers 42 ins. in diameter, with Krupp steel tires, 48 ins. diameter on the tread. The first and third pair of driving wheels in each truck are 5¾ ins. wide and flanged, the middle pair are plain, or blind, 6⅜ ins. wide. The truck wheel tires are of Krupp open hearth steel. The axles are of hammered iron, with cast-steel springs made by A. French & Co. The main rods have universal joints connected to levers operated by the cross-head, and the side or coupling rods have solid ends. The feed water is supplied by Sellers and Friedman injectors. The cab is of ⅛-in. steel. The boiler and cylinders are lagged with wood and jacketed with iron. The casings of cylinder heads and tops of steam chests are of pressed steel. The driving-box lining and connecting rod bearings are of Damascus bronze. There are two Nathan double sight-feed lubricators. The saddle tanks have ¼-in. plates for sides and bottom, and 3-16-in. for top and inside of legs. The engine is fitted with the New York automatic air brake, operating shoes on the front of all driving wheels. There is one engineer's valve, and one No. 7 duplex pump, the pump mounted on one smoke-box. The accompanying table gives the leading dimensions and particulars of these engines.

RUNNING GEAR:	
No. of drivers (two driving trucks)	12
No. of truck wheels (two pony trucks)	4
Driving wheels, diam.	4 ft. 0 ins.
Truck " "	2 " 4 "
Engine truck, length of radius bar	4 " 9 "
Engine truck, swing or rigid center	swing
Journals, driving axles	7⅛ ins. diam. × 10 ins.
Journals, truck axles	5 " " × 10 "
WHEEL BASE.—Driving (each driving truck 8 ft. 4 ins)	32 ft. 10⅞ ins.
Truck, including drivers and pony truck	14 " 10 "
Total engine	45 " 10⅞ "
C. of pony truck pin to c. of leading driver	6 " 6 "
Drivers having blind tires, middle pair of each group.	
WEIGHT, in working order; on drivers	210,000 lbs.
On truck wheels	40,000 "
Engine, total	250,000 "
Of full coal capacity	10,000 "
Of full water capacity of tank	25,000 "
Allowed for water in boilers	16,000 "
CYLINDERS, h. p.	13 × 24 ins.
l. p.	28 × 24 "
Ration of area of h. p. to l. p.	3 to 1
Distance, c. to c.	6 ft. 11 ins.
Distance, center to valve face	1 " 9¼ "
Piston rod, diam.	2¾ "
Crosshead and guides; 2-bar guides; h. p. and l. p. piston rods keyed to same crosshead.	
Connecting rod, length between centers, main or inner	6 ft. 5 ins.
Connecting rod, length between centers, return or outer	7 " 7 "
VALVE GEAR.—Type, F. W. Johnstones' (Eng. News, April 9, 1892).	
Ports; length	14 ins
Ports; width, steam...h. p., 1¼ ins.; l. p., 1½ ins.	
Ports; width, exhaust...h. p., 1¼ ins.; l. p., 2¾ ins.	
SLIDE VALVES: lap., min. h. p., 1 in.; l. p., 1-16 ins.	
Max. level...h. p., 5½ ins.; l. p., 4½ ins.	
Lead...h. p., 3-16 in.; l. p., ½ in.	
BOILERS.—Type, straight; Otis steel.	
Diam. of barrel inside (at smokebox end)	4 ft. 6¼ ins.
Thickness of barrel plates	9-16 in.
Thickness of smokebox tube plate	½ "
Height from rail to c. line	7 ft. 3 ins.
Length of smokebox	4 " 6 "
Working steam pressure	180 lbs.
FIREBOXES.—Type, Belpaire, Otis steel.	
Length inside	4 ft. 8 ins.
Width inside	4 " 8 "
Depth at front and back	6 ft. 4¾ "
Thickness of side plates	5-16 "
Thickness of back plate	5-16 "
Thickness of crown sheet	⅜ "
Thickness of tube sheet	½ in.
Crown staybolts, diam.	1 in.
Grate area (each firebox)	2.17 sq. ft.
Ratio of area to heating surface	1.25 per cent.
Staybolts, diam.	⅞ in.
Staybolts, pitch	4¼ ins.
Water space, width, 3½ ins. at sides; 4 ins. at front and back.	
TUBES.—Material, Franklinite, No. 13 B. W. G.	
Number	201
Pitch	2¾ ins.
Diam. inside	1.81 "
Diam. outside	2 "
Length outside tube plates	15 ft. 9⅛ "
Total fire area of tube openings	7.95 sq. ft.
HEATING SURFACE:	
Ratio of tube area to firebox heat, surf., 7.83 per cent.	
Firebox, each boiler... 126 sq. ft.; total, 252 sq. ft.	
Tubes, each boiler...1,608 " " total, 3,216 " "	
Total, each boiler...1,734 " " total, 3,468 " "	
MISCELLANEOUS:	
Exhaust nozzle, diam.	4½, 4¾ or 5 ins.
Smokestack, smallest diam.	15½ "
Smokestack, height from rail to top	13 ft. 8⅞ "
Capacity of tank	3,000 gallons.
Capacity of coal space	10,000 lbs.
Brake fittings, New York auto. air on all drivers.	
Total adhesive tractive power, at ¼ of weight on drivers	52,500

ERROR RESULTING FROM THE USE OF THE JOLLY AIR THERMOMETER.

By Prof. R. C. Carpenter, Cornell University.

In recent temperature determinations made in the Sibley College Laboratories with the air thermometer, by Mr. C. H. Eldridge, instructor, large

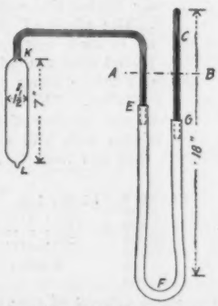


Fig. 1. The Jolly Air Thermometer.

errors were found which an investigation showed to be due to the structure of the instrument. As the air thermometer is the standard to which important temperature determinations are referred,

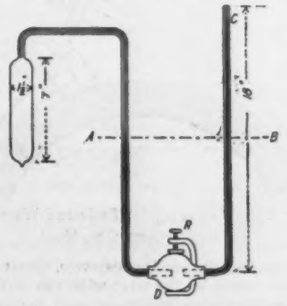


Fig. 2. Modified Form of Jolly Thermometer.

and as the instrument employed has the form commonly recommended for such instruments, knowledge of the character and amount of errors in various forms became of practical moment. Incidentally it may be mentioned that the investigations resulted in the comparison of several forms of air thermometers.

Air is a perfect thermometric substance, and if a given mass of air be considered, the product of its pressure and volume divided by its absolute temperature is in every case constant. It follows from this that if the volume of air remain constant, the temperature will vary with the pressure; if the pressure remain constant the temperature will vary with the volume. As the former condi-

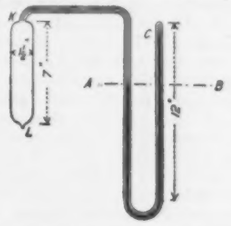


Fig. 3. Air Thermometer with Glass Tubes.

tion is more easily attained air thermometers are usually constructed of constant volume, in which case the absolute temperature will vary with the pressure.

If we denote pressure by p and p^1 the corresponding absolute temperatures by T and T^1, we should have

$$p : p^1 :: T : T^1 \text{ and } T^1 = p^1 \frac{T}{P}.$$

The absolute temperature T is to be considered in every case 460 higher than the thermometer

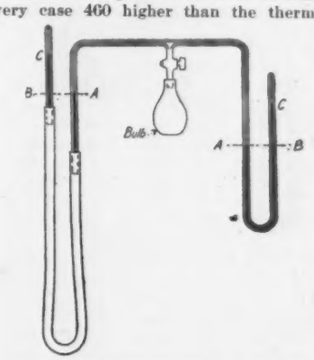


Fig. 4. Air Thermometer with Siphons.

reading expressed in Fahrenheit degrees. From the form of the above equation if the pressure be corresponding to a known absolute temperature T can be found, the quotient is a constant which may be used in all determinations with the instrument. The pressure on the instrument can be expressed in inches of mercury, and is evidently the atmo-

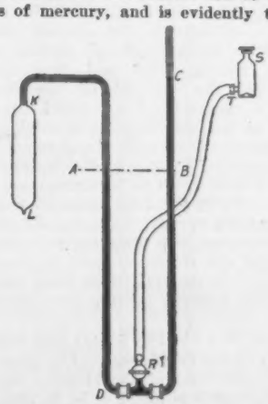


Fig. 5. The Preston Air Thermometer.

spheric pressure b as shown by a barometer, plus or minus an additional amount h shown by a manometer attached to the air thermometer.

That is in general $p = b \times h$.

The temperature of 32° F. is fixed as the point of melting ice, in which case $T = 460 \times 32 = 492°$ F. This temperature can be produced by surrounding the bulb in melting ice and leaving several minutes

so that the temperature of the confined air shall acquire that of the surrounding ice. When the air is at that temperature, note the reading of the attached manometer h, and that of a barometer; the sum will be the value of p corresponding to the absolute temperature of 492° F. The constant of the instrument, K = 492° + p, once obtained can be used in all future determinations.

For the benefit of those not practically familiar with the air thermometer, I will state that the form usually recommended in text books is known after its inventor as the Jolly and is shown in Fig. 1. It consists of a glass bulb K L about 1½-1½ ins. diameter and 8 ins. long; the size and shape being immaterial. This is connected with a glass stem, K A E, of any convenient length and about 2 mm. bore and 6 mm. outside diameter; to this glass stem is connected a rubber tube, E F G, connected to a straight glass tube of similar size, G B C. The bulb L K is filled with dry air, the rubber tube with mercury. The Jolly form is easily constructed, and the mercury in the tube E D is readily adjusted so that its height shall always stand at the fixed mark A, by raising or lowering the tube G C as needed, thus preserving the volume of confined air constant, as required in the theory of the ordinary instrument. The detailed method of construction can be found in several works, as for instance Kohlrausch's "Physical Measurements," Carpenter's "Experimental Engineering," article Heat in Encyc. Britannica.

The method of using is as follows:

Let t = the temperature to be measured.

Let b = the barometer reading in inches of mercury.

Let h = the reading of mercury column B C' above a fixed mark A. The bulb L K is packed in melting ice to find a constant to be used in all determinations made with the instrument. This constant is equal to 492 + (b + h), which we will represent by K. To use the instrument, set it in any convenient place with the bulb K L, in the space whose temperature is to be measured, note the reading of the barometer which we term b', also the height of the mercury column B C above the fixed mark A; call this h.

Find the true temperature in degrees Fahr., as

$$t = (b \times h) - 460.$$

There are a few corrections for expansion of glass and mercury that can be omitted unless it is desired to read very minute fractions of a degree.

In some recent experiments the form shown in Fig. 2 was used, which differs from the Jolly form shown in Fig. 1, in the substitution of the rubber bulb D R for the rubber tube E F G. To bring the mercury to the fixed mark A, pressure was applied to the rubber bulb by a screw clamp R, the instrument being used as explained. The Jolly instrument is the one usually employed when air thermometers are required and so far as the writer knows no complaint or suspicion has attached to any determinations made with it. In the experiments referred to, the attempt was made to find the temperature of boiling point as well as freezing point and thus check the accuracy of the constant of the instrument. Contrary to expectation it was found that with the constant of the instrument as determined at the freezing point, the temperature of steam at atmospheric pressure is shown by the instrument with the rubber bulb was 8 to 10 degrees too low, and that as shown by the Jolly instrument was 10 to 20 degrees too low.

An examination was made covering every possible cause of this error; the purity of the mercury was tested, the determinations were repeated in very possible manner, but the error could not be located.

The form shown in Fig. 3 was then substituted; in this the rubber tube is replaced by glass, it being essentially the form of the Hoadley instrument. This instrument was found to be correct, and the constant determined for freezing point would give the boiling point correctly. This instrument has no fixed point in the tube A D; consequently the volume is not quite constant. A correction can be made to the results if necessary, but for temperatures under 212° this will scarcely ever be needed.

A further determination of causes of failure of the Jolly instrument was made by mounting on a cross pipe the rubber siphon and glass siphon as shown in Fig. 4 in such a manner as to be subjected to the same pressure applied by a hand bulb. This experiment showed conclusively that the rubber siphon was not reliable in its measurements, as it varied from ¼ to ⅛ of an inch in height as compared with the glass siphon subject to the same pressure.

The probable error was due to adhesion of the mercury to the rubber. The failure of the Jolly form of thermometer to work caused us no little trouble and delay and the query has arisen in the mind of the writer, whether other engineers who are in the habit of using the air thermometer for temperature determinations had noted such errors. For my own part I may say that we are satisfied that rubber is not a suitable material for the tubes of an air thermometer, on the other hand the thermometer with a glass-siphon is accurate and reliable.

It should be added that although several kinds of rubber were tried in these experiments, it seems probable that from the extensive use of such a form of air thermometer some kinds of rubber are exempt from the errors found.

A form of air thermometer with a device for maintaining constant volume as designed by Mr. Geo. B. Preston, of Sibley College, is shown in Fig. 5. The instrument is used as the others; but as the expansion of the air in the bulb drives the mercury in the tube A D below the mark A, the stop cock R is opened and the bottle S T, which is filled with mercury, elevated until sufficient mercury has been added to bring the mercury back to the point A, after which the cock is closed and readings taken as with continuous glass tubes. If the mercury in the tube A D is too high, by opening the cock R and lowering the bottle it can be brought to the proper level. In this case the rubber tube R T is merely used to supply or remove mercury and has no effect on the readings.

IMPROVEMENTS TO THE WORKS OF THE BUTTE CITY WATER CO.

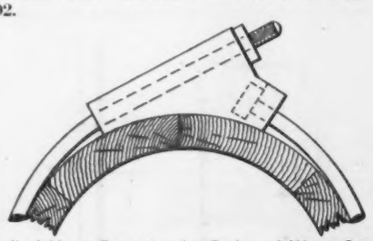
By J. H. Harper, C. E.

The Butte City Water Co. purchased the plant and good will of the old Silver Bow Water Co., together with the franchise and estate of the old Silver Bow Hydraulic Mining Co., something more than one year ago. The plans of the purchaser contemplated that an entirely new system of distribution should be placed upon the old plant which rendered it possible to utilize about nine miles of pipe from the old system. The following is a statement of the size and number of feet of kalameined iron pipe, jointed with lead and calked in the usual manner, that has been laid during the past season:

Diam., Ins.	Length, ft.	Diam., Ins.	Length, ft.
4	5,000	16	1,500
5	800	18	1,700
6	58,500	20	15,000
8	16,000		
10	14,000	Total	125,000
12	12,500		

In laying the above amount of pipe the company has set 296 two-nozzle and 36 three-nozzle fire hydrants.

The new dam of the company, now under construction, was described in our issue of Dec. 8 1892.



Detail of Hoop Fastening for Redwood Water Supply Conduit at Butte City, Mont.

In connecting the service reservoir, situated about nine miles south of the city, with the distributing mains, wooden pipe has been used for the most part and 47,300 ft. constructed under the Allen patent by the Excelsior Redwood Co., of California, has been laid for this purpose.

The redwood for the pipe arrives upon the ground in staves sawed accurately to lengths of 10, 12 or 14 ft., with the outside planed to the curve represented by the circumference of the pipe desired, while the edges are beveled with a view to fitting accurately when in position, each stave having a slight bead running from end to end upon one edge only.

A saw kerf about ½ in. in depth is made in the end of each stave. The hoops arrive upon the ground as long bolts or rods of ½-in. steel, threaded at one end for about 2½ ins. and with a square head upon the other. They are rapidly bent upon the ground while cold by a very simple appliance, after which they are treated to a coat of mineral paint.

The joints are made by taking plates of iron of a thickness that will fit snugly in the saw kerfs upon the end of the stave, of such a width that they will bed very firmly in the bottom of the kerf when the staves are driven home, and of such a length that they will project probably ⅛ in. beyond the staves which they are joining and enter the edge of the stave upon either side. The joints are invariably broken. The hoops are used and fastened by a malleable iron clip in the manner shown in the sketch herewith, which to all appearances makes a very neat, substantial and convenient fastening. The hoops are placed along the pipe from 2 to 5 ins. c. to c., depending upon the pressure under which the different sections of the pipe are expected to be working.

A special advantage of this method of construction seems to be manifested by the ease by which the pipe may be turned and made to accommodate the crooks in the line, or fit the contour of the ground over which it is being run.

I was much pleased with the manner in which this pipe was erected, as it appeared to be well done with an exceedingly small quota of what we consider skilled workmen, and it certainly looked neat and substantial when completed.

The intersection of the city's two most prominent thoroughfares, Park and Main Sts., falls upon the the contour of 5,700 ft. above sea level, and the company anticipates that fire protection will be given upon all hydrants situated below this contour by gravity pressure.

In the pipe alinement from the reservoir to the city an attempt has been made to keep as near the hydraulic grade as practicable with a consistent regard for the shortest line, and it has been possible to obtain a flow under moderately light pressure to a point about two miles south of the city, where the pipe descends to cross the valley of Silver Bow Creek. All moderate increases in pressure were met by decreasing the interval between the bands of the wooden pipe, which interval has ranged from 6 to 2½ ins. In crossing gulches where the pressure has exceeded 150 ft., iron pipe has been inserted for a short distance between the wooden sections, and 20-in. iron pipe has been used entirely from the point where the line descends to cross the valley of Silver Bow Creek, where a maximum pressure of 450 ft., with the reservoir empty, is attained.

A flow of 6,000,000 gallons a day is anticipated through this line when the water is drawn from the reservoir to very near the level of the delivery pipe, and a considerably greater flow when the reservoir is full.

Further plans of the company contemplate the distribution of water throughout the cities of Butte and Walkerville, and the towns of Meaderville and Centerville in three different systems, the water level in each of which will be about 350 ft. above the one below. As above stated, the first system will cover the contour of 5,700 ft., and will supply the lower portion of the city and the towns of South Butte and Meaderville; the second system is intended to cover a contour of 6,000 ft., and will supply the upper portion of the city of Butte and a part of Centerville, while the third will reach a contour of 6,300 ft. and will supply the mines on the hill and the city of Walkerville. The two systems last named will be supplied by pumping from the system below, and the company is now engaged in building the lower of these two plants, just under the contour of 5,700 ft., and hopes within 30 days (from Dec. 1) to have its Knowles duplex double-acting pump of 800,000 gallons capacity per diem moved from its present

location upon Silver Bow Creek to the new station, and have it pumping water from the first into the second system.

In addition to the Knowles pump above named, it is the intention of the company, at a later day, to place a Worthington high-duty engine of 4,000,000 gallons capacity at this point, and the station is being designed for its reception.

It is the company's further intention to build a second station in the vicinity of Centerville, and force the water from the second into the third supply system, but the details of this plant are not at the present time obtainable. As a moderate amount of water, probably a minimum of 15 miner's inches, known as the Bulls Run supply, coming from the hills on the north, can doubtless be made available for this system it is probable that a pumping plant of comparatively modest proportions will be deemed sufficient. All work here has been done under the supervision of Mr. Eugene Carroll, and to his courtesy I am indebted for much of the information given.

MUNICIPAL REFORM FROM THE POINT OF VIEW OF A MUNICIPAL ENGINEER.

A paper with the above title prepared by Mr. Geo. W. Rafter, M. Am. Soc. C. E., was read Nov. 15 before the Chamber of Commerce, of Rochester, N. Y. Mr. Rafter discussed the lack of business principles in connection with municipal affairs and the corruption so often attendant upon the expenditure of large sums of money for municipal improvements. He disapproved of the application in America, as paternal and undemocratic, of the methods which are so successfully employed in some European cities. Municipal management by experts, as practised in St. Louis was reviewed (see Eng. News, Jan. 23, 1892) by Mr. Rafter.

Some of Mr. Rafter's comments upon the St. Louis system and the concluding words of his paper are as follows:

The foregoing exhibits enough of the St. Louis system to indicate that it is a practical exemplification of the useful sphere of action of specially qualified experts in municipal administration. Its organization as a whole is such that the interests of all are fairly conserved. The political aspirant may find field for activity in the municipal legislature while the interests of the tax-payer are protected from encroachments for political purposes purely by the conservative tendencies of the expert board.

Finally the St. Louis system is an American development and for this, if for no other reason, may well receive careful attention before we conclude to import the paternal system of the European cities. Probably it has numerous faults, some of which more extended experience will correct; that it will ever become ideal is improbable. It has, however, the merit of reasonableness from the American point of view and this fact also will commend it to the many municipalities whose people, dissatisfied with the present methods, are groping in the dark, in what, in many cases, is only a blind search for the new.

It is clear, then, from the nature of the work, that when the day finally arrives for a general management of the business of municipal corporations by trained experts, the demand in the beginning must be principally upon the profession of municipal engineers, and we may properly close this paper by briefly considering whether, if the demand were made at once, the profession would respond in fitting form. In answering we must remember that whatever there is of skill in present municipal management, is due to the municipal engineers who, as the professional advisers of the various controlling boards, are tacitly, although not legally, at the head of municipal affairs; if, nevertheless, the general question is answered, in some degree, in the negative it is still no part of the author's intention to reflect upon the profession of which he is proud to be a member. Criticism of ones own profession is, however, in the nature of self-examination and may be, therefore, at times properly indulged in. From this point of view it appears that municipal engineers must attain a higher standard of professional ethics before the profession can as a whole successfully assume the responsible management of municipal corporations. The effect of long habit is not easily eliminated and the inevitable result of the prevailing condition is that too many of the municipal engineers are but pliant tools in the hands of astute politicians. As a starting point, therefore, what is needed most of all is a race of skillful municipal engineers who are unpurchaseable, have the courage of their convictions, and are so thoroughly experienced as to insure that municipal design shall be ordinarily free from technical blunders. That there are many men in the profession answering to these requirements is conceded; that the profession as a whole does not answer to them is an undisputed truth.

PUMPING EXPENSES, WATER CONSUMPTION AND WASTE PREVENTION, MONTREAL WATER-WORKS.

The cost of pumping at the Montreal city water-works in 1891 is given in the last annual report of Mr. B. D. McConnell, Superintendent, as follows:

Low Service.

	Amount pumped.	Cost.	Cost per U. S. million gallons* pumped: To reservoir. 168.9 ft.	1 ft. high
Water power....	4,419,298,800	$5,412	$1.2247	$0.00725
Steam power....	1,884,750,000	21,527	11.4180	0.06775

High Service.

Steam power....	246,358,168	5,808	23.697**	0.11125

* All gallons have been reduced to U. S. measure.
** Pumped 213 ft. to reservoir.

The total low service pumpage for the year was 6,304,044,000 gallons of which 70.1% was pumped by water power and 29.9% by steam power. The steam pumps are of local and Worthington make. The average daily consumption was 17,271,600 gallons against 17,280,000 gallons in 1890. The population by the census of 1891 was 216,650, which gives an average daily consumption of about 80 gallons per capita during each year.

The purposes for which water was used in 1891 and the amounts for each purpose are given in the report as follows:

	Millions of U. S. gallons.
No revenue:	
Flooding private rinks	.53
Fires	16.92
Watering streets	78.79
Public fountains	50.22
Harbor latrines and drinking taps	14.68
Lubricating steps of turbines	21.05
	182.19
Metered and charged at meter rates:	
Factories and engines	192.12
Elevators	202.76
Railways	121.74
Schools, convents, etc	31.26
Hospitals and homes	8.45
Hotels	45.26
Church organs	8.35
Breweries	31.98
Miscellaneous	21.68
Outside municipalities	53.66
	717.26
Balance, that charged for at rates based on rental, being principally domestic consumption	5,404.15
	6,303.60

The total number of meters in use at the end of the year was 702, of which the city owned all but 56. During the year there was a net gain of only nine meters. The total number of services at the end of the year was about 45,000.

The low consumption noted, low as compared with many American cities, is doubtless due to the metering of nearly all but domestic services and to persistent house to house inspection. From the beginning of the year until Nov. 24 there were 9, and during the remainder of the year 14 inspectors and a foreman. With the smaller force about nine months were required to make a round of the city.

The result of the inspection in the years 1890 and 1891, expressed in number of fixtures out of repair and waste per hour, is as follows:

	1890. Fixtures.	1890. Waste.	1891. Fixtures.	1891. Waste.
Bib cocks	3,763	51,982	4,180	63,872
Urinal "	82	1,873	61	1,378
Ball "	2,006	45,137	3,334	81,127
Stop "	54	980	68	1,254
Closet "	191	6,286	189	5,548
Basin "	263	4,028	382	5,528
Closet valves	126	3,432	373	9,902
Water closets	36	1,372	20	368
Pipe burst	741	14,559	676	15,446
	7,262	129,649	9,283	184,423

The waste in 1890 was, therefore, at the rate of 3,311,576 gallons per day and in 1891 it was 4,426,152.

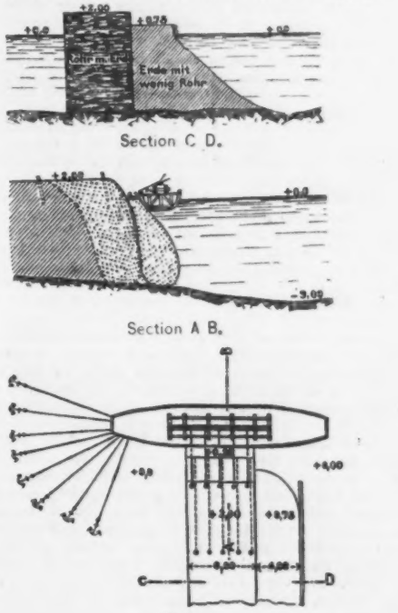
In addition to the waste caused by defective fittings there were found in 1891, 18 taps open, to prevent freezing, which were wasting 810 gallons per hour and 16 taps open to flush drains, wasting 756 gallons per hour.

There were also found 52 cases of illegal use of water for building purposes and 164 cases of illegal use of hand hose in 1891. During the year there were 91 prosecutions brought by the inspection department. The total number of houses inspected during the year was 84,159.

DIKE CONSTRUCTION ON THE YELLOW RIVER, CHINA.

The disastrous overflows of the Yellow River have necessitated the construction and maintenance of an extensive system of dikes. The materials used are earth and reeds which are easily obtained in the vicinity. The method of repairing these primitive dikes is illustrated in the accompanying engraving for which we are indebted to the "Centralblatt der Bauverwaltung" which periodical gives the following particulars:

On the windlass of a boat moored alongside the break in the dike are wound heavy cables, consisting either of hemp, bamboo or vegetable fiber. The ends of the cables are secured to stakes driven in the crown of the remaining part of the dike. Layers of reeds and earth are alternately piled on the cables, which, forced by the increasing weight of those materials, will sink, assisted by gradual unwinding of the drum or windlass, until the net thus formed is filled to above water's edge and bottom is reached. At this stage, we presume the ends of the cables are detached from the windlass and secured to the stakes mentioned above. The boat is then shifted and the new cables placed in position, ready to receive the materials for the next section. It is asserted that breaks of more



DIKE CONSTRUCTION ON THE YELLOW RIVER, CHINA.

than 6,500 ft. in length in occasional depths of 100 ft. of water and at a considerable velocity of current, were repaired by this method in a very short time. It is evident that at first these dikes will settle to a great extent, so that filling up has to be resorted to frequently, until the spaces in the bank have been filled in by silt, etc. carried by the rivers. The dikes are secured on the down stream side by wide earth buttresses, the outline of which is shown on section CD. These are constructed in a manner similar to that described. They are easily undermined by the current, but can quickly be reconstructed with the handy and cheap materials.

TRACTION ENGINES AND THEIR USE.

The value of traction engines or road locomotives for hauling purposes, and particulars of their design and use, have been made the subject of recent articles in our columns (Eng. News, Oct. 27, Nov. 10 and Dec. 1, 1892), and we give below an abstract of a paper by Mr. John McLaren, one of the leading English builders of these engines, published in the "Ironmonger," of London.

Notwithstanding the numerous obstacles in the way of the development of steam transport on common roads, thousands of traction engines are in daily use in all parts of the United Kingdom, some for hauling produce from farms to the railway stations, returning with feeding stuffs and artificial manures; some are used by colliery owners, brick manufacturers, quarry

owners, brewers and millers for hauling their productions to their markets; but the greatest number are used for hauling threshing machinery from farm to farm, and for driving the machine by means of a belt from the flywheel of the engine, which can be used as a stationary motor for that purpose. For this work the traction engine is rapidly superseding the portable engine, which has hitherto been generally employed. The perfection to which steel founding has attained has been of material assistance to traction engine makers, for it has enabled them to combine enormous strength with comparative lightness in the gearing and other important details of construction. Except for some extraordinary accident, the time required to do a certain number of miles can be gaged with tolerable accuracy. The various parts of the engine are so proportioned to each other and balanced that a laborer of ordinary intelligence can soon become a qualified driver, and go out to his daily task with almost as much confidence as the driver of a railway locomotive, who has a special track prepared for his engine to travel upon. As an instance of ordinary experience, an engine 16 years old was threshing up to noon, and then started off a distance of 14 miles to bring back a sleeping-van which had been left behind some time previously. It arrived at its destination in course of the afternoon, and then went back with the sleeping-van, thus doing the 28 miles in the afternoon and evening of the same day.

The use of traction engines in this country would be greatly extended if it were not for the numerous legislative restrictions imposed upon them by act of Parliament. One foolish clause in the present act is that which specifies that the road wheels of traction engines shall be "cylindrical and smooth-soled, or shod with diagonal crossbars, not less than 3 ins. wide, nor more than ¾ in. thick or 3 ins. apart." By so stipulating the exact construction of the wheels a bar is put upon all improvements therein, and in certain cases where obvious improvements have been made in the construction of traction engine wheels, county councils have refused to grant licenses to engines so fitted, on the ground that they do not conform to the requirements of the act, notwithstanding the evidence of surveyors and others that the wheels in question are less injurious to the roads than the old-fashioned wheels made in accordance with the provisions of the act of Parliament.

These hindrances have greatly militated against the extended use of traction engines. Moreover, with the extraordinary network of railways which we possess, the scope of the traction engine for the transport of large quantities of merchandise is necessarily somewhat limited. But in foreign countries, and in our own colonies there is a much wider field for their use. For high speeds the necessity of mounting the engine on springs is imperative; and as this mechanical difficulty is now effectually solved, the utility of the engine is greatly increased. By means of engines specially designed, an express parcel service was established and satisfactorily worked between Grenoble and Lyons, in France, a distance of about 70 miles. The enterprise was worked in opposition to the railway, the journey being made by night at an average running speed of 8 miles per hour, with a net useful load of 5 tons. In New Zealand spring traction engines are regularly employed for hauling produce down from the farms to the ports, returning with stores and other station requisites. One such engine, traveling with an average net load of 20 tons, has made the trip from Christchurch to Grassmere and back, a total distance of 150 miles, in 2½ days, including the time required for loading. The road rises to a height of 3,000 ft. above the starting point. By the old arrangement 11 teams of 10 bullocks each, or 110 bullocks in all, would have been required to do the same work, taking about 12 days for the trip.

In England the cost of transport can be reduced in favorable circumstances to about 4 cts. per ton per mile by means of traction engines, and one firm of quarry owners saved as much as $2,460 in the first year by the use of a traction engine, upon ascertaining which they at once went in for two more, and now do all their cartage by steam. For hauling large marine boilers, heavy castings, armor plates, etc., traction engines are invaluable. In Liverpool a traction engine has hauled a total load of 80 tons (viz., a boiler weighing 60 tons, on a trolley of 20 tons weight) a distance of nearly two miles in less than an hour. Only three men were required to do the work with the engine, whereas in the old way it would have required over 60 horses and 20 or 30 men, interrupting all the traffic in the streets for hours.

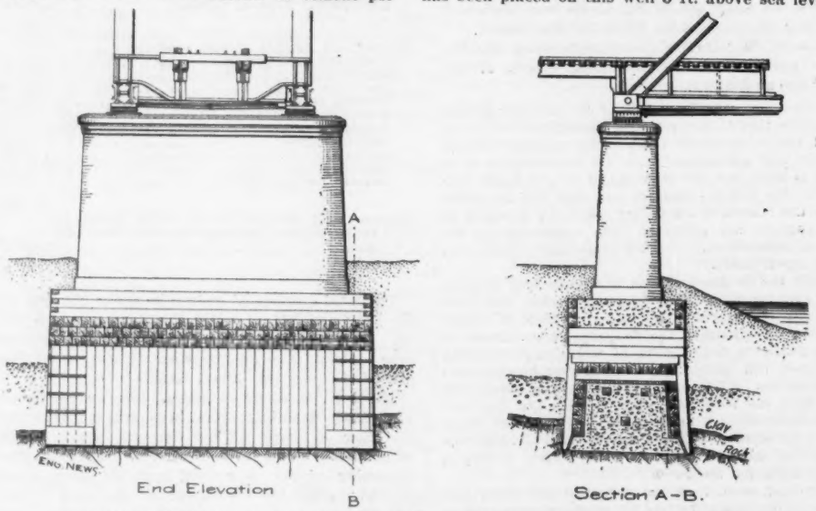
COST OF FOUNDATIONS OF SAGILLA RIVER BRIDGE; BRUNSWICK & WESTERN R. R.

By W. B. W. Howe, Jr.

In the accompanying cuts are shown the details of one of the piers for a bridge over the Sagilla River, on the line of the Brunswick & Western R. R., built under the writer's supervision during 1891. In constructing this bridge it was apprehended that considerable difficulty would be experienced in putting in the foundations, both on account of sunken logs and spring freshets in the river, and as it was important to have the new bridge completed at as early a date as possible pneumatic caissons were employed. The sinking was done by day labor and with such foremen and laborers as could be obtained in the neighborhood. Work began at the west foundation Dec. 25, 1890, and the piers were ready for the superstructure early in May, 1891. The following is the detailed statement of the cost of the work, which will compare favorably with similar work elsewhere:

	East pier.	West pier.
Cost of caisson	$2,119	$2,131
" " crib	291	157
" " sinking	1,653	1,920
" " concrete in air chamber	836	686
" " concrete in crib	456	301
" " pier	1,423	1,404
" " coping	423	436
Totals	$7,201	$7,035
Cost of foundations		$14,237
" " superstructure		31,000
" " machinery		6,000
Total		$51,237
Cost of lumber per M. ft., in place, in caisson, including iron		$30.50
" " lumber per M. ft., in place in crib		22.00
" " sinking per vertical ft.		103.00
" " concrete in air chamber per cu. yd.		7.90
" " brick per thousand in pier		19.84
" " foundations per cu. yd. below low water		15.35

The piers were built of hard burned brick, laid in Portland cement. Two barrels of cement per 1,000 bricks were used and every course was grouted with neat cement grout.



FOUNDATIONS OF SAGILLA RIVER BRIDGE; BRUNSWICK & WESTERN R. R.

The superstructure was designed for two ten-wheel locomotives, each weighing 216,000 lbs., including tender. All truss members, floor beams, stringers, and all members of the lateral systems are of steel. The floor is of creosoted cross ties. The contract for the superstructure was let to the Edge Moor Bridge Works, of Wilmington, Del., in Dec. 1890, and the bridge was ready for trains early in July, 1891.

THE ARTESIAN WELLS OF OAHU.

By C. H. Kluegel, C. E., Honolulu, H. I.

Oahu, one of the Hawaiian Islands, has an area of 600 sq. miles. It is of volcanic formation, and is fringed with a nearly continuous coral reef. The coral, raised a few feet above the sea level, extends a mile or more inland in many localities.

There are two ranges of mountains, one 15 miles in length along the southwest side of the island; the other, 30 miles in length, extends parallel to the northeast coast. In the latter range the highest peaks are 3,000 ft. high. The southwest slope of this range is much the longer one, with numerous deeply eroded ravines. The northeast slope is precipitous. Nearly the entire summit of the range is covered with vegetation.

The northeast trade wind, which prevails here, enters this cool mountain region, the moisture is condensed and falls in largest quantity just after crossing the summit. The rainfall in this region is about 12 ft. annually, five times as great as on the south shore of the island. The ground is porous, the streams carry off only a small portion of the rainfall. This region appears to be the source of the artesian waters.

There are about 160 artesion wells on the island. Their depths vary from 200 to 1,100 ft., and may average 500 ft. The various strata consists of soil, clayey earth, tufa, coral and hard lava. In one case a layer of hard coral 500 ft. thick was pierced. The water bearing stratum is generally a hard, black or gray, porous lava, from which the water flows freely. The wells are generally cased with screw-joint pipe, and their sizes vary from 5⅝ to 9⅝ in. inside diameter.

The height to which the water rises varies from 28 to 42 ft. above the sea level on the south side of the island, while at some other points it rises only a few feet. This height varies with the rainfall, and decreases very slightly upon the boring of new wells in the near vicinity of others.

There is great difference in the flow of different wells, probably owing mostly to the difference of head according to the elevation of the surface.

In a well having a depth of 405 ft., an inside diameter of 9⅝ ins., I found the flow to be 3.6 cu. ft. per second at an elevation of 5 ft. above sea level, with a head of 30 ft.; and 2.3 cu. ft. per second with a head of 10½ ft. A hydraulic ram has been placed on this well 5 ft. above sea level. It discharges 0.18 cu. ft. per second at an elevation of 80 ft., and 0.11 cu. ft. per second at 96 ft. above sea level.

The wells, like the numerous and large natural springs which apparently come from the same source, are mostly used for irrigation, and more extensively for rice than for any other crop. The temperature of the water is 73° Fahr.

Many of the wells and most of the springs are in the vicinity of Pearl Harbor. On the Ewa sugar plantation, west of Pearl Harbor, there are 22 wells with inside diameter of 9⅝ in. and an average depth of 450 ft. From 20 of these wells water is now pumped for the irrigation of 2,500 acres of sugar cane, and this area will be increased. At one of the three pumping stations there is a group of six wells on the lines of a rectangle and 50 ft. apart. When allowed to flow at the surface of the ground, which gave a head of only 5 ft., their combined flow was 15 cu. ft. per second. Opening five of these wells and allowing them to flow freely caused the water standing in the last well to fall only 0.3 ft., indicating a free flow to the wells from an abundant supply.

Considering the limited area on which there is a large rainfall and from which the supply can come, the abundance of the flow of artesian water on this island is remarkable.

AN OPPORTUNITY FOR CHEMICAL MANUFACTURERS.

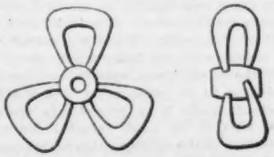
The city of Butte, Mont., has a smoke problem on its hands for solution beside which the smoke problem with which Chicago and the cities in the Mississippi Valley are wrestling sinks into insignificance. The smoke which makes life intolerable in Butte comes not from the incomplete combustion of soft coal, but from the smelting furnaces, where the sulphur in combination with the copper in the ore is driven off. In Butte's early days, when only a few smelters were in operation, the sulphur fumes were regarded as rather beneficial to health than otherwise; but taking an occasional sulphur bath is one thing, and breathing constantly an atmosphere highly charged with sulphur dioxide another. At present, or rather until the recent temporary shut-down of some of the principal smelters, the sulphur fume nuisance was too great to be endured.

All sorts of schemes are proposed for getting rid of the fumes, but only two seem to have any prospect of success. It is apparent that no improvement in smelting furnaces can cure the difficulty. For a given amount of ore roasted a given amount of sulphur must be oxidized and driven off. The sulphur fume production being a settled fact, the only practical methods of dealing with it are either to collect and condense it as sulphuric acid or to carry it away and discharge it at a distance from the city. The latter plan has been worked out in some detail by Mr. Jos. U. Harper, C. E., of the firm of Baker & Harper. He proposes to construct two large masonry flues, following the contour of the ground and taking the fumes from all the smelting works in operation. One flue would discharge at a point over two miles distant from the city and at an elevation of about 400 ft. above the valley in which it lies, while the other would be led in the opposite direction, and would deliver its vapors at a point three miles distant from the business center and nearly 1,000 ft. above it. A preliminary estimate of the cost of the flues with the necessary branches indicates a probable cost of about $600,000.

It is questionable, however, whether this is the best solution of the difficulty. If the fumes could be collected for disposal by a flue, they could doubtless be collected and washed for the manufacture of sulphuric acid. It may be that the high price of fuel, high freight rates, or distance to markets would make the industry unprofitable; but if a portion of the money which would be required to build the proposed flue were offered as a bonus to any one who would establish a chemical plant to rid Butte of its sulphurous atmosphere, it seems altogether probable that the problem would be permanently solved in short order, and perhaps to the great ultimate advantage of the city.

A NOVEL FORM OF SCREW PROPELLER.

The screw propeller, of which a sketch is shown herewith, was briefly described in a discussion at the last meeting of the Institution of Mechanical Engineers, and is such a simple and apparently such a sensible innovation as to deserve the attention of those interested in marine engineering. As seen by the drawing, a much larger proportion of the blade area is located near the outer circumference of the propeller than is the



A Novel Form of Screw Propeller.

case in the ordinary screw. Thus a given thrust will be attained with a lower rate of revolution and with less churning action upon the water near the center. The strength of the screw is also claimed to be considerably greater than that of the ordinary form, as may be easily understood by a glance at the side view.

These propellers were stated in the discussion to be in use and doing good service on two large passenger steamers plying between Liverpool and Birkenhead, and on several tugs in use about the port of Liverpool. The passenger boats have shown increased speed with very little vibration, whereas one of them, when fitted with the ordinary screw, vibrated to an alarming extent. Of the tug boats fitted with this screw, one can now manage 11 barges, where formerly she took only 8, and another has had her towing capacity increased 25%. As for strength, one of these tugs struck the propeller, which was of cast iron, upon a rock, but did it no injury beyond scratching the blades.

Besides the uses of this propeller in marine service, it is possible that designers of ventilating fans and pressure blowers and screw propeller pumps might copy it with advantage.

SUBDIVISION OF POWER BY THE USE OF SMALL ENGINES.

The subdivision of power in large manufacturing establishments by the substitution of several small engines in place of one large engine, and the distribution of power in the form of steam rather than by shafts and belts, was originally looked upon as an experiment which might show against the fuel account, and the practice was some time in gaining the confidence of manufacturers or engineers. Among the advocates of subdivided power, as engineers, has been the firm of Westinghouse, Church, Kerr & Co., New York, which has designed many important plants on this basis.

When the great Spreckels sugar refinery was built, some four years ago, Mr. Watson, the chief engineer, adopted this system entirely. Not only was the subdivision of power so completely carried out as to involve over 60 engines distributed on every floor of the building, and practically doing away with shafting and belts altogether, but high-speed engines were selected, and most of them set without foundations. Non-compound engines were employed, from the fact that the various processes utilized all the exhaust steam which could be made. This refinery has since passed into the ownership of the American Sugar Refining Co., and further enlargements are now in progress, the experience of three years of operation, literally night and day, being brought to bear upon the question of future extension of power. As a result an order has been placed with M. R. Muckle, Jr., & Co., of Philadelphia, for five more Westinghouse "Standard" engines, four of 100 HP. and one of 75 HP., making 68 engines now operating in this refinery.

An interesting feature developed in this establishment has been in the matter of repairs and stoppages. The master mechanic keeps on hand a set of duplicate parts for each size of engine, and covering such parts of the engine as are most subjected to accident or wear. When a part is worn out or an accident occurs, he gives the spare part to the engineer in charge of that particular department, and it is at once put in place; the old part being returned to the shop and overhauled at leisure. In this manner there is no measurable delay in the refining processes, which is the paramount consideration, and the maintenance account is reduced to a very low figure.

A similar subdivided plant involving 42 engines was installed at the print works of the Dunnell Mfg. Co., Pawtucket, R. I., and its chief engineer is said to have reported that the total repair bill for the first year of continuous operation was less than $3.

TEST OF FIRE PROTECTION PIPE LINE AT CLEVELAND, O.

A line of pipe for fire protection only, to be operated from a fire boat in the river, was tested on Sept. 13, 1892, at Cleveland, O. We are indebted to Mr. M. W. Kingsley, Superintendent of the Cleveland Water-Works, for the following information.

The pipe is laid up Seneca St. hill to Champlain St., a distance of 1,000 ft. It is 6 ins. in diameter, weighs 46 lbs. per ft. and is laid 3 ft. deep. There are three two-way hydrants with 3½-in. openings, one at Canal St., at an elevation of 37.2 ft.; one at Michigan St., at an elevation of 72 ft.; and one at Champlain St., at an elevation of 84.4 ft. The hydrants are the Crane Company's make, of Chicago, with independent nozzle and without valve or rod at the base. On Sept. 11 the fire boat was connected to the pipe at the river end with three lines of 3½-in. hose. The boat's pumps were run at a maximum water pressure of 160 lbs. A gage was attached to the hydrant at Champlain St., the highest point, which showed the following pressure, about 250-ft. streams having been thrown. First test, one line of hose 50 ft. long at Canal St., 2-in. nozzle:

Pressure at pumps, 100 lbs.; at Champlain St., 0 lbs.

Pressure at pumps, 140 lbs.; at Champlain St., 20 lbs.

Pressure at pumps, 160 lbs.; at Champlain St., 80 lbs.

Two lines of hose, 50 ft. long each, at Canal St., with two 2-in. nozzles:

Pressure at pumps, 100 lbs.; at Champlain St., 0 lbs.

Pressure at pumps, 140 lbs.; at Champlain St., 20 lbs.

Pressure at pumps 160 lbs.; at Champlain St., 50 lbs.

One line at Canal St. and one at Michigan St.:

Pressure at pumps, 100 lbs.; at Champlain St., 0 lbs.

Pressure at pumps, 140 lbs.; at Champlain St., 20 lbs.

Pressure at pumps, 160 lbs.; at Champlain St., 51 lbs.

With one line at Michigan St.:

Pressure at pumps, 100 lbs.; at Champlain St., 0 lbs.

Pressure at pumps, 140 lbs.; at Champlain St., 20 lbs.

Pressure at pumps, 160 lbs.; at Champlain St., 54 lbs.

With two lines at Champlain, the gage at Michigan St.:

Pressure at pumps, 100 lbs.; at Michigan, 40 lbs.

Pressure at pumps, 140 lbs.; at Michigan, 60 lbs.

Pressure at pumps, 160 lbs.; at Michigan, 74 lbs.

There also is a line up Superior St., and the putting in of a few more lines is contemplated.

BOILER PITTING CURED BY GRAPHITE AND OIL.

In an article in the "American Machinist" Mr. T. T. Parker states that in a certain boiler pitting was found in the mud drum. The drum was cleaned and scraped, after which it was painted with graphite mixed with cylinder oil. Measurements of the depths of the pits were taken, and six months after they were found no deeper, and no new ones were found. Other parties have since tried this experiment in mud drums, but it is too early as yet to give the result. However, knowing the character of plumbago, if the interior of a boiler could be painted with it in such a way that it would stay, it may be this would prove a remedy. He is satisfied also that the person doing so would kill two birds with one stone, as the scale could be easily detached. In a pair of cylindrical boilers, 42×28, occasional applications of cylinder oil (mineral) and plumbago have kept back corrosion on a trial of six months. Boilers were new when plumbago was used. The boilers which the new ones replaced were thrown out rotten from corrosion. The feed was mine water, as nothing else could be had. It is also stated that Harig, Koop & Co., Louisville, Ky., after experiencing more or less trouble from rust and scale in the mud drums of the boilers, applied with great success graphited oil, purchased from the Joseph Dixon Crucible Co., Jersey City. The mud drums were cleaned out and the graphited oil applied with swab or brush to the joints and parts where the water enters the drums. This process is repeated every four or six weeks.

LEGAL DECISIONS OF INTEREST TO ENGINEERS.

Specific Enforcement of Filtration Contract by Water Company.

Where a water company, under its contract with a city giving it an exclusive franchise, has established its plant, laid its water pipes in the streets, and private consumers have, at large expense, conducted the water into their houses, a provision of the contract making it the duty of the company to filter the water intended for domestic use, will be especially enforced at the suit of the city, as an action for damages by the private consumers would be wholly inadequate, and a forfeiture of the exclusive franchise of the company would entail on the city the needless expense of erecting new works. The fact that the company, under its contract, has the right to pump unfiltered water through its pipes in case of fire, does not excuse it from its failure to filter the water at other times.

The fact, that a filter put in by the company was adequate when its works were constructed, does not excuse it from putting in a new one after the old has become inadequate by reason of the city's growth, and the consequent increase in the demand for water. The fact that the city may have delayed in applying taxes raised by it to the payment of the interest and principal of the company's bond, as required by the contract, and that it ordered the company to lay pipes where they were not required, will not defeat its action for specific performance; it appearing that all taxes had eventually been applied as provided for in the contract, and that the city had not insisted on compliance with its order respecting the laying of pipes. (City of Burlington v. Burlington Water Co. Supr. Ct. of Iowa, 53 N. W., Rep., 246.)

Fire Liability Cannot Be Contracted Away.

The Iowa statute provides that "any corporation operating a railway shall be liable for all damages by fire that is set out or caused by operating such railway"; and another section provides that a common carrier cannot exempt itself from liability as such carrier by contract. A contract between the owner and operator of an elevator, coal shed, and corn-cribs, and a railroad company, exempting such company from liability for damages by fire negligently set by its engine, is void, where it appears that such buildings were built and used for the purpose of promoting the business of such railroad company. (Griswold v. Illinois Central Ry. Co. Supr. Ct. of Iowa, 53 N. W. Rep., 294.)

Construction of Municipal Water-Works in Colorado.

The statutes of Colorado, relating to towns and cities, confer power on municipal authorities to construct water-works, either within or without the corporate limits; to protect the streams from which the water is taken within a certain distance from their borders, and to do whatever may be necessary to erect and protect their system. Under this statute a town was authorized to proceed under the eminent domain act to condemn land outside of the corporate limits, and within the specified distance, necessary for a ditch to convey a supply of water to the town. In such case the power to determine whether the construction of water-works is justified by the necessities of the town is wholly within the province of the municipal authorities, and is not a question for submission to the jury in the condemnation proceedings. (Warner v. Town of Gunnison. Ct. of Apls. of Colo., 31 Pac. Rep., 238.)

Liability for Bridge Breaking Under Threshing Outfit.

In an action against a county for an injury to a team and threshing outfit, caused by the breaking of a bridge while attempting to drive across it, is for the jury to determine whether the use which was being made of the bridge was unusual and extraordinary, and such as the county was not bound to anticipate; and a verdict in favor of the owner will not be disturbed on the ground that such use was improper. It cannot be said as a matter of law, that the use which was being made of the bridge was unusual and extraordinary, and such as the county board was not bound to anticipate. Such machines are in common use, and of necessity are frequently moved along the highways and across the bridges of the county. Their passage is not so frequent as vehicles in more common use, but the same is true of four and six-horse teams, and yet a court would not declare, as a matter of law, that the passage of such was not to be anticipated. (Yordy v. Marshall County. Supr. Ct. of Iowa, 53 N. W. Rep., 208.)

Appropriation of Water.

Where a person constructs and maintains a dam in a stream on public lands for the purpose of supplying a canal with water to be used for beneficial purposes, he acquires a possessory interest in the dam, the pond formed by it, and the land under the pond, and others will be enjoined from extending a canal into the pond, even though their intention is to take only the surplus water after the former's canal has taken its supply. (Natoma Water & Min. Co. v. Hancock. Supr. Ct. of Cal., 31 Pac. Rep., 112.)

PERSONAL.

Mr. E. E. Jaycox, Traffic Manager of the World's Columbian Exposition, has resigned his position.

Mr. Henry M. Phillippi, an engineer of construction on the Pennsylvania R. R., died last week at Elizabeth, N. J.

Mr. N. C. Van Natta has been appointed Chief Engineer of the Midland Terminal R. R., with headquarters at Cripple Creek, Colo.

Mr. W. M. Corbett has been appointed Superintendent, in charge of the operating, mechanical and maintenance of way departments, of the Evansville & Terre Haute R. R.

Mr. Frank Elmaker has been appointed Superintendent of Terminals, at Philadelphia, for the Pennsylvania R. R. He was formerly Superintendent of the Sunbury Division, and lately of the Amboy Division. He will have charge of the road from Fifty-ninth St., on the west, to the Delaware River, on the east, and from South St., north, to Manayunk and Bristol.

Mr. Henry Goldmark has opened an office in the Rialto Building, Chicago, Ill., for practice as a civil engineer, and will make a specialty of the design, supervision and construction of all classes of structural work, particularly railway and highway bridges, iron buildings and roofs, masonry structures and foundations. He has had experience in these specialties for over 12 years, during four of which he was engaged on a large railway system as Engineer of Bridges.

Mr. Rudolph V. Martinson died in New York, N. Y., Dec. 24. He was born in Revel, Russia, in 1851, and came to this country in 1877. In 1883 he represented the Dutch interest in a financial syndicate, with a capital of $30,000,000, through which the Canadian Pacific Ry. was built, and he became also a member of the executive committee of this syndicate, with W. L. Scott, of Erie; Jacob H. Shiff and John S. Kennedy, of New York, as co-members. After the liquidation of this syndicate he became a member of the Board of Directors of the Canadian Pacific Ry., and remained as such for over five years. In 1888 he was elected President of the Missouri, Kansas & Texas R. R., holding that office for 18 months. He formed the Consolidated Coal Co., of Wyoming, in 1890, and was its president up to his death. He represented also many financial interests in this country in railways, coal, gold and silver mines and other valuable concerns.

NEW PUBLICATIONS.

JANUARY MAGAZINES.—In the "North American Review" Alvan G. Clark, the famous maker of great telescopic lenses, discusses the future possibilities of the telescope, and contradicts the general impression that a limit to the size of great telescopes is nearly reached. He affirms his ability to grind lenses of much greater size than have yet been made, and believes that the glass blocks for such lenses will yet be successfully cast. Kellar, the magician, tells some stories of high-caste Indian magic. According to him the Indian fakirs in some of their tricks suspend the attraction of gravity, and possess hypnotic powers far beyond anything which the French school has produced. Senator Chandler defends with considerable skill his proposition that immigration should be totally suspended for one year, and there are two interesting discussions on co-operation, and on incorporated and responsible labor organizations as solutions of the labor problem, the former written by Hon. David Dudley Field. "Harper's" opens with an interesting description of the journey from St. Louis to New Orleans on a Mississippi steamboat, a route for travel little patronized nowadays, but full of picturesque scenes, and reminiscent of ante-bellum days and Mark Twain's stories. A paper by the late Theodore Child on "Proletarian Paris" sketches with an artistic hand the life of the Parisian workingman and workingwoman. The poverty and misery which underlie the life of this teeming city he passes over too lightly, however, to suit the serious student of his subject. In "Scribner's" Mr. Angelo Heilprin, Chief of the Peary Relief Expedition, tells the story of last summer's successful voyage of the "Kite" to Lieutenant Peary's winter camp, at McCormick Bay. The "Century" has a very interesting and fully illustrated paper on "The Great Wall of China," by Mr. Romyn Hitchcock, whose recent description of Chinese telegraph and railway lines will be remembered by our readers. The Great Wall is by far the most herculean work ever performed by any nation prior to the days of modern civilization. A barricade 1,500 miles long, and high and strong enough to turn back an army at any point is a work unparalleled in the amount of labor required. At the part of the wall most visited it is 15 to 30 ft. high, 25 ft. thick at the base and 15 ft. at the top. The wall is in remote parts a mere earth or stone embankment; but elsewhere it is faced on both sides with stone or brick masonry laid in mortar. The base is often of huge granite blocks. On top, the wall is paved with large square bricks. The main part of the wall was constructed about 1,200 years ago; but the parts that are now well preserved are not more than 400 to 500 years old. Dr. Washington Gladden outlines a scheme for the reform of a city's municipal service. It appears to be an ideality instead of an actual experience which is described by the writer, under the title of "The Cosmopolis City Club," but the ideas set forth are, nevertheless, worth serious attention.

In the "Popular Science Monthly" we find an account of the invention of the lightning rod which ascribes the original invention to Prokop Divis, a Bohemian priest, who was born in 1696 and died in 1765. On June 15, 1754, after some years of experimental research in electricity, he erected a lightning rod 132 ft. high in the open field near his dwelling. As Franklin printed a description of his lightning rod in the 1753 edition of "Poor Richard's Almanac," it is difficult to see on what ground Divis can be called a prior inventor.

BUILDINGS AND STRUCTURES OF AMERICAN RAILROADS.—A Reference Book for Railroad Managers, Superintendents, Master Mechanics, Engineers, Architects, and Students. By Walter G. Berg, C. E., Principal Assitant Engineer, Lehigh Valley Railroad. New York. John Wiley & Sons; 4to, pp. 500; 691 illustrations; $7.50.

There is no criticism which is more frequently made on technical books than that they are behind the times and do not represent present practice. This is more or less true of all books, which are not kept up to date by frequent revision and additions, after they have been a year or two in print, and it is true of a great many at the very time they are issued. The reason for this is easily found. Years of time may be devoted to the writing of an original treatise, and the field of observation of any single man, no matter what his position and abilities, must necessarily be comparatively narrow.

But on many subjects of technical importance on which no treatise of value exists, there can be found in the files of technical journals, and the proceedings of technical societies, a great mass of recent and valuable information, but so widely scattered and so poorly indexed as to be practically unavailable. The author who will collect and intelligently edit and compile this scattered information on any subject may provide a valuable work and do a real service to the profession, especially if he takes pains to fill any void in his compiled material by searching for and adding original matter. This is, briefly, the method pursued by the author of the book before us, and he has been able in this way to produce a work as nearly representative of the best and most recent practice as would probably be possible. Besides the illustrations and descriptions reprinted from technical journals, he has collected much original material from railway officers, and he has done good and careful work in editing and arranging the matter collected. The plan of the work is simple and commendable. A separate chapter is devoted to each class of structures. Each chapter opens with brief general remarks by the author on general principles governing the design of the structure under discussion, and then follow descriptions and illustrations of buildings of this class actually erected. The structures described include not only the more important classes of passenger and freight depots, engine houses, etc., but structures to the design of which comparatively little attention has been paid, such as ashpits, sand houses, oil mixing houses, signal towers and water stations. The work is a useful, needed and very creditable one.

ELECTRICITY AND MAGNETISM: A Series of Advanced Primers of Electricity, by Edwin J. Houston, A. M. New York, The W. J. Johnston Co., Ltd.; 12 mo., pp. 306; 116 cuts. $1.00

In 1884, during the International Electrical Exhibition, at Philadelphia, Professor Houston prepared a series of "electrical primers" intended to explain the elementary principles of electricity to general readers. But knowledge of the rudimentary principles of electricity is now so widely spread that a much more advanced text book can profitably be taken up by the man who, starting with the smattering given by the high school or college course, wishes to inform himself more fully concerning the principles and applications of electricity. The book before us represents not a revision of the original primers, but an entirely new work, couched in plain language and easily comprehended by any reader of reasonable intelligence who will devote to it the necessary amount of study. It is devoted principally to the general nature of electricity and magnetism; and the reader who wishes an explanation of the mode of operation of a dynamo or a voltmeter, or a telegraph instrument will not find the information here. Two other primers soon to be issued by the same author, however, will take up the practical applications of electricity, and will be much more intelligible, doubtless, to the reader who makes a careful study of the foundation principles contained in this book.

THE MINING DIRECTORY AND REFERENCE BOOK Of the United States, Canada and Mexico. Containing list of Mining and Quarrying Companies and Operators, Smelters, Reduction and Sampling Works and Blast Furnaces. Giving location of same, names of officers, annual output, stamp mills, coal breakers, washers, coke ovens, etc. Also lists of mining, mechanical and electrical engineers, assayers, geologists, metallurgists, mine inspectors, mineral land surveyors, brokers, mining exchanges and investment companies, mining and commercial attorneys. Together with the mining codes of the different countries and digests of the statutes relating to corporations, liens and mining in the different states and territories, and the Canadian provinces. Also the railways, water routes and express companies to all points at which above interests are located, or nearest shipping point. George W. Ramage, Editor. Chicago: Poole Bros. 4to, 551 pp. $10.00 for the United States, Canada or Mexico. £2 1s. 6d. for other countries.

After so comprehensive a title little need be said of the scope of this work. While we cannot pretend to test the accuracy of the information given, it can be said that the work bears outward evidence of great labor and care in its preparation, and the broad field covered should make it an exceedingly useful book of reference. One of its most valuable features is the section relating to the mining codes of various countries and the digest of the statutes of the United States and Canada relating to this subject. These codes and statutes vary widely, and their presentation in one volume, for reference and comparison, is a work in ifself worth the cost of the whole directory. Over 100 pages of double column fine type are devoted to this information alone. The classification of mines is alphabetically by states, with the products under separate heads. This is the first edition of the directory, but it is the purpose of the publishers to issue it annually.

THE WASHINGTON BRIDGE, Harlem River, New York. A description of its construction, by Wm. R. Hutton, Chief Engineer. Large, 4to, with 63 albertype and lithograph plates. Leo von Rosenberg, publisher, 35 Broadway, New York.

The publisher announces that he has reduced the price, between now and Feb. 1, 1893, from $8.00 to

$5.00, or $5.50 express paid. We have already noticed this work as a complete description of the handsomest bridge in the neighborhood of New York, and cheap enough at the original price.

DEEP-SEA SOUNDING. A Brief Account of the Work Done by the U. S. S. "Enterprise" in Deep-Sea Sounding during 1883-1886. By Capt. A. S. Barker, U. S. N. New York. John Wiley & Sons. 8 vo, pp. 133; three large charts.

This is a plain and simple record, in the form of a diary, for the most part, of a difficult and tedious duty well performed. The "Enterprise" went around the world, taking deep-sea soundings all the way, and also making frequent observations of compass variations. In doing this it discovered two submarine peaks in the South Atlantic, and an extensive sand bank off the south coast of Brazil, with another large shoal in the Pacific, near New Zealand. It took a continuous line of soundings all the way from New Zealand to the Straits of Magellan, which to this day remain the most southerly ever taken in the Pacific, and practically the only ones for some degrees to the north. It also took the second deepest sounding ever taken in the North Atlantic, and one of the deepest taken anywhere, 4,529 fathoms, 40 miles from the spot (just north of Porto Rico), where the U. S. S. "Blake" sounded in 4,561 fathoms, or 5.2 miles, the deepest Atlantic sounding on record.

The "Enterprise" cruised under sail, using steam for soundings and emergencies only. As a rule, one cast per day was taken, which brought them only some 100 miles apart, and not a single cast was skipped, some of them being taken in very tempestuous weather, and some of them of course much closer together.

The routine was to start fires two hours before the cast in two of the six boilers. When steam was up the ship was headed to the wind, the propeller coupled up, the cast made, fires hauled and ship put on her course again, only ½ ton of soft coal being required for each cast. In spite of all this hauling of fires, Captain Barker writes that not a stick of cord-wood was bought during the whole voyage; empty boxes and barrels furnished all the fuel.

For the compass observations, taken every 15°, the ship was swung first to starboard and then to port, and occasionally with the ship listed 6° to 10°, keeping "steady" on each point at least four minutes.

No comments are made as a rule upon the facts narrated, but they are by no means strictly confined to technical details; a feature of special interest, for example, being the detail accounts of the Krakatoa earthquake and general catastrophe of Aug. 27, 1883, which the "Enterprise" happened to escape by a few hours only. The quiet narrative of this appalling occurrence is very impressive.

An odd instance of the style of the work, which we cannot forbear to note, is the record of entering the harbor of Tamatave, Madagascar, on July 4, 1883. Four French and one English man-of-war were there. Of course the "Enterprise" would "dress ship" in honor of the day, and, of course, it was etiquette for the other men-of-war do so likewise. "It was pleasing to note how quickly the foreign men-of-war followed the movements of the "Enterprise" in dressing ship. A national salute had been fired at sea in honor of the day, and our flags bent on in readiness to hoist and dress ship with a "rainbow" upon letting go the anchor. This was done, and simultaneously (note the word) the English man-of-war hoisted her flags, dressing in "rainbow," and a moment later (!) all the French ships were covered with bunting."

Between "simultaneously" and "a moment later" there was time enough for quite a voluminous critique on the discipline of the respective services in Captain Barker's mind, we may be sure, though he forbears to do more than note the fact in simple justice to the Englishman.

A curious fact in the sounding records is that in nearly all the deep-sea soundings the temperature of the bottom was 33° to 35°. If 39° is the temperature of the maximum density of water, how does this happen on so large a scale? Possibly, under such enormous pressure there is a difference in the temperature of maximum density.

SOCIETY PROCEEDINGS.

AMERICAN FORESTRY ASSOCIATION.—The annual meeting was held at the Department of Agriculture, Washington, D. C., Dec. 20. Mr. B. E. Fernow, Chairman of the Executive Committee, presented his report, in which, it was stated that there are at present six reservations of forest, representing a total of 3,252,260 acres. These are as follows: White River, Pike's Peak and Plum Creek, Colorado; Pecos and Canadian River, New Mexico; Bull Run, Oregon; and Yellowstone National Park timberland reserve, lying south and east of Yellowstone Park, Wyoming. A public state park was proclaimed last August at Lake Itaska, Minn., headwaters of the Mississippi River. There are 26 proposed forest reservations now being considered and are situated in the states of California, Colorado, Idaho, Minnesota, Montana, New Mexico, North Dakota, Oregon, Washington, and Wyoming.

There was an animated discussion on the merits of the Paddock bill, now on the Senate calendar, which proposes to place the control of the timberland in the hands of the Secretary of Agriculture, who will be given administrative action in order to protect and utilize the timber. The proposed reservations are not land desired for agricultural purposes. The following officers were elected for the ensuing year: President, Hon. Sterling J. Morton, Arbor Lodge, Neb.; Treasurer, Henry M. Fisher, Philadelphia, Pa.; Secretary, Dr. N. H. Egleston, Department of Agriculture, Washington, D. C.; Corresponding Secretary, J. D. W. French, Boston, Mass.; Chairman of Executive Committee, B. E. Fernow, Chief of the Forestry Division, U. S. Department of Agriculture, Washington, D. C.

ENGINEERS' CLUB OF CINCINNATI.—At the November meeting Col. Latham Anderson read a paper giving some suggestions concerning the proposed Miami & Erie Ship Canal, a bill to appropriate $10,000 for the survey of which was introduced in Congress last winter by Senator Caldwell, and another by State Senator Gear, for the issue of $40,000,000 of state bonds, the proceeds to be devoted to the building of the canal. The dimensions of the canal, as contemplated by the Caldwell bill, are as follows: width on flow line, 150 ft.; depth, 15 ft.; width on bottom, 105 ft. The fifth annual meeting was held Dec. 15, with 31 members present. The reports of the secretary and treasurer were presented, showing the club to be in a satisfactory condition. The following officers were elected: President, Col. Latham Anderson; Vice-President, W. B. Ruggles; Directors, M. D. Burke, Chas. A. Ewing and H. L. Hoeffer; Secretary and Treasurer, J. F. Wilson. Mr. Whinery, the retiring president, chose for the subject of his address, "Ethics of Engineering," and we shall publish an abstract of this address.

ENGINEERS' CLUB OF ST. LOUIS.—At the meeting on Dec. 21, President Johnson in the chair, and 39 members and one visitor present, the result of the election of officers for 1893 was announced, as follows: President, Robert Moore; Vice-President, B. L. Crosby; Secretary, Arthur Thacher; Treasurer, Chas. W. Melcher; Directors, J. B. Johnson and Geo. H. Pegram; Librarian, R. E. McMath; Members Board of Managers Association of Engineering Societies, J. B. Johnson and J. A. Ockerson. President Johnson, with a few appropriate remarks, relinquished the chair to the newly-elected president, who, after thanking the club, called on the retiring president for an address, and Professor Johnson gave an interesting address on the "Engineering Profession." Secy. Arthur Thacher.

CIVIL ENGINEERS' CLUB, OF CLEVELAND.—At the meeting on Dec. 13, Mr. James Ritchie read a short paper on "Cross Ties on Railway Bridges," and Mr. W. W. Sabin read a paper on "Fire-Resisting Construction." This paper dealt with the methods of fireproof and slow burning construction in use at the present day. The protection of columns and girders was briefly described, but the construction of the various types of floors and partitions was entered into in detail. Special notice was drawn to the efforts of the inventors to lighten the weight of the floors, and thereby reduce the expense of the constructional iron work. Architects were advised to encourage all such efforts in that direction by giving them their serious consideration. The paper closed with a statement of the weights and cost per square foot of the different styles of floors and partitions. Chas. S. Howe, Secy.

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.—The annual convention of 1893 of the Master Car Builders' and Master Mechanics' Associations will be held at the Kent House, Lakewood, N. Y., the first beginning Tuesday, June 13, and the second Monday, June 19. Lakewood is on the New York, Lake Erie & Western R. R., at the southern end of Lake Chautauqua. Hotel rates will be $3 per day.

The committee of the Master Mechanics' Association on "Attachments between Engine and Tender" send out a circular letter asking replies to the following questions, which should be addressed to J. Davis Barnett, Chairman, Stratford, Ont.:

1. With engines coupled to tenders by single stout link and large pins, so strong as not to break loose under heaviest pull, have the tank frames any marked tendency to either mount or run under the cab footplates? In other words, is there any more risk from the tender-frame than there is from the tank leaving frame and sliding into cab?

2. If the tender frame has such tendency, can it be prevented? If so, are the probable expense, weight and work required to prevent it, in your opinion, justified?

3. If not using such a device, are you familiar with any fastening, equipment or invention that is designed to prevent tender-frame mounting? If so, will you illustrate or describe it?

4. If in a position to give an opinion as to its practical usefulness, kindly do so.

5. Do you use or recommend safety couplings on each side of the ordinary simple main coupling? If so, should the side safety couplings be single, weldless links or short sections of welded chain?

6. Do you use or recommend anything to prevent wear of the chafing surfaces between engine and tender; or make the chafing surfaces of any particular shape, size or metal?

7. What, if any, means do you use to take up the heavy wear that comes on main coupling-link, pins and chafing surfaces?

8. If you have used any elaborate connection between engine and tender, did you experience any difficulty in backing up a heavy train (tender first) around a sharp curve, due to flange friction, caused by tender not readily setting to curve?

Foot-Steps and Hand-Rails.

9. Are long steps safer or more advantageous than short steps having good high flanges to prevent the side movement of foot after it has once touched the step?

10. Are there any materials for steps (or the working faces of steps) safer and better, in all states of weather and greasiness, than roughened iron?

11. If so, what are the qualities they possess? Illustrate or describe the manufacture, shape and size, saying how the material is used.

12. Should side steps on engine and tender be the same height—that is, in line—the one with the other?

13. What is the best height from top of track tie to working face of first step. Would increasing the number of steps and lessening the vertical height (or the riser), in your estimation, add to the safety of the men?

14. Are long upright handles safer and more effective than short handles?

15. Is there any usefulness in long horizontal hand-rails on tank?

16. Are low hand-rails and foot-steps desirable at the front end of any engine equipped with a pilot?

17. If any improvement in hand-rails or foot-steps is desirable on yard engines, should not road engines be similarly equipped, both for safety and uniformity?

COMING TECHNICAL MEETINGS.

ASSOCIATION OF CIVIL ENGINEERS OF DALLAS.
Jan. 6. Secy., E. K. Smoot, 808 Commerce St.
TECHNICAL SOCIETY OF THE PACIFIC COAST.
Jan. 6. Secy., O. Von Geldern, 719 Market St., San Francisco.
NORTHWEST RAILROAD CLUB.
Jan. 7. Union Station, St. Paul.
MONTANA SOCIETY OF CIVIL ENGINEERS.
Jan. 7. Secy., F. D. Jones, Helena.
SWEDISH ENGINEERS' CLUB.
Jan. 7. Secy., P. Valentine, At 281 Union St., Brooklyn, and 646 North 10th St., Philadelphia. At 180 La Salle St., Chicago Secy., John Ericson.
ENGINEERS' CLUB OF PHILADELPHIA.
Jan. 7. 1122 Girard St. Secy., L. F. Rondinella.
WISCONSIN POLYTECHNIC SOCIETY.
Jan. 9. Secy., M. F. Schinke, City Hall.
ENGINEERS' CLUB OF KANSAS CITY.
Jan. 9. Secy., Waterman Stone, Baird Building.
NORTHWESTERN SOCIETY OF ENGINEERS.
Jan. 10. Secy., D. W. McMorris, Burke Block, Seattle, Wash.
DENVER SOCIETY OF ENGINEERS AND ARCHITECTS.
Jan. 10. Secy., Geo. H. Angell, 35 Jacobson Block.
ATLANTA SOCIETY OF CIVIL ENGINEERS.
Jan. 10. Secy., Parker N. Black, Capitol Block.
CIVIL ENGINEERS' ASSOCIATION OF KANSAS.
Jan. 11. Wichita, Kan.
NEW ENGLAND RAILROAD CLUB.
Jan. 11. Secy., F. M. Curtis, O. C. R. R., Boston.
ENGINEERS' CLUB OF MINNEAPOLIS.
Jan. 12. Secy., F. W. Cappelen, 1628 Hennepin Ave.
ENGINEERS' AND ARCHITECTS' CLUB OF LOUISVILLE.
Jan. 12. Secy., Edward Mead, Norton Building.
ENGINEERING ASSOCIATION OF THE SOUTH.
Jan. 12. Secy., O. H. Landreth, Nashville, Tenn.
NORTHWESTERN TRACK AND BRIDGE ASSOCIATION.
Jan. 13. Secy., D. W. Meeker, St. Paul.
ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
Jan. 17. Secy., R. H. Clark, Pittsburg.
WESTERN RAILWAY CLUB.
Jan. 17. Rookery Building, Chicago. Secy., W. H. Marshal.
BOSTON SOCIETY OF CIVIL ENGINEERS.
Jan. 18. Secy., S. E. Tinkham, 36 Broomfield St.
MICHIGAN ENGINEERING SOCIETY.
Jan. 17, 18, 19. Annual meeting at Lansing, Mich. Secy F. Hodgman, Climax, Mich.
ENGINEERS' CLUB OF ST. LOUIS.
Jan. 18. Secy., Arthur Thacher, Odd Fellows' Building.
IOWA CIVIL ENGINEERS' AND SURVEYORS' SOCIETY.
Jan. 18. Annual meeting, Court House, Des Moines, Ia. Secy., Seth Dean, Glenwood, Ia.
AMERICAN SOCIETY OF CIVIL ENGINEERS.
Jan. 18, 19. Annual meeting. Secy., F. Collingwood, 127 East 23d St., New York.
SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
Jan. 19. Atlanta, Ga. Secy., F. A. Charpiot, Macon, Ga.
NEW YORK RAILROAD CLUB.
Jan. 19. Secy., H. G. Prout, 73 Broadway, N. Y.
ENGINEERS' CLUB OF CINCINNATI.
Jan. 19. Secy., J. F. Wilson, 24 W. 4th St.
SCANDINAVIAN ENGINEERING SOCIETY OF CHICAGO.
Jan. 19. Secy., C. F. Franson, Portiano Block.
TACOMA SOCIETY OF ENGINEERS AND ARCHITECTS.
Jan. 20. 201 Washington Building.
CANADIAN SOCIETY OF CIVIL ENGINEERS.
Jan. 20. Secy., C. H. McLeod, Montreal, P. Q.
CENTRAL RAILWAY CLUB.
Jan. 25. S. W. Spear, E. Buffalo, N. Y., Iron Works.
INDIANA ENGINEERING SOCIETY.
Jan. 24, 25, 26. Annual meeting at South Bend, Ind. Secy. E. B. Vawter, Lafayette, Ind.
WESTERN SOCIETY OF ENGINEERS.
Feb. 1. Secy., Jno. W. Weston, 51 Lakeside Bldg., Chicago.
CIVIL ENGINEERS' SOCIETY OF ST. PAUL.
Feb. 6. Secy., C. L. Annan, City Engineer's Office.
CIVIL ENGINEERS' CLUB OF CLEVELAND.
Feb. 7. Secy., Chas. S. Howe, Case School.
ENGINEERS' SOCIETY OF PHŒNIXVILLE.
Feb. 7. Secy., W. Halliburton.
AMERICAN INSTITUTE OF MINING ENGINEERS.
Feb. 21, etc. Annual meeting, Montreal, Que. Secy., R. W Raymond, 6 Burling Slip, New York, N. Y.

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AND

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ADVERTISING RATES: 20 cents per line agate measure. Schedule sent on request. Changes of advertisements must be in hand on Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements, not later than Wednesday noon. The last pages go to press early on Thursday. We shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay.

The premiums offered by the Engineering News Publishing Co.* for the best theses (under the conditions of the offer) submitted by 1892 graduates from any engineering course of any American college have been awarded as follows:

The first premium of $75 has been awarded to the thesis entitled "Investigation as to the Effect of Retempering Upon the Strength of Cement Mortars," which proved to be the work of Messrs. L. H. Goddard, of Dunham, O., and P. P. Evans, of Chillicothe, O., graduates of the Ohio State University, Columbus, O. This paper is published on another page of this issue.

The second premium of $50 has been awarded to the thesis entitled "Losses in Iron Under Alternating Magnetic Forces," which proved to be the work of Mr. John E. Moore, of Coesse, Whitley Co., Ind., graduate of Purdue University, Lafayette, Ind.

The third premium of $25 has been awarded to the thesis entitled "The Variation of the Coefficient of Friction with Different Loads and Bearing Metals," which proved to be the work of Messrs. Joseph Kerber, of Lima, O., and Robert T. Mickle, of Millville, N. J., graduates of Sibley College, Cornell University, Ithaca, N. Y.

Honorable mention, accompanied in each case by a two-years' paid subscription to Engineering News, has been awarded to the following theses:

"The Hardening of Steel and Its Effect Upon the Ultimate Resistance," by Mr. Elmer James Bucknell, of Decorah, Ia., graduate of the Rensselaer Polytechnic Institute, Troy, N. Y.

"The Effect of Overstrain in Metals," by Mr. Harry Feldmeir, of Brooklyn, N. Y., graduate of the Rensselaer Polytechnic Institute, Troy, N. Y.

"Arrangement of Tracks and Interlocking and Signaling of Blairsville Intersection," by Mr. Frank Rhea, of Saltsburg, Pa., graduate of the Western University of Pennsylvania, Allegheny, Pa.

The judges deem that all the above papers, but especially those awarded premiums, are of a high order of merit. The judges were unanimous in awarding the above premiums.

The Engineering News Publishing Co., encouraged by the satisfactory results which have attended this first offer of premiums for the best graduating theses, offers the following premiums for the best graduating theses of 1893, open to any 1893 graduate in any engineering course of any college of the United States or Canada:

For the best graduating theses (under the conditions below stated), first premium, $75; second premium, $50; third premium, $25.

For such other theses as may seem to deserve such recognition, honorable mention, accompanied in each case by two years' paid subscription to Engineering News:

The conditions of the competition will be as follows:

1. Competing theses must be sent in by the college authorities, not by the authors. They must be sent in anonymously, both as to author and college, indorsed on the outside, "For Engineering News Thesis Competition," and addressed in care of Francis Collingwood, Secretary of the American Society of Civil Engineers, 127 East 23d Street, New York, who has kindly consented to receive and open the packages. They must be accompanied by a sealed envelope endorsed on the outside with the title of the thesis, and containing within the name, address and college of the author and a certificate from some one of his professors to the effect that the thesis has been examined and is indorsed as one in all known respects worthy of entering such a competition. These sealed envelopes will be retained and opened by Mr. Collingwood after the announcement of the awards has been made to him.

2. The examinations and awards will be made by the editors and associate editors of Engineering News, assisted by such experts in the several branches of engineering as they may select to aid them in reaching a just decision.

3. The basis of selection for premiums will be the same as that used in selecting papers for publication in engineering journals or society proceedings; that is to say, theses will be graded according to their apparent permanent value for the advancement of engineering practice or theory, either as records of original research, or as intelligent and concise discussions or critical summaries of older reseaches. Clearness, conciseness and care in summarizing conclusions will be essential merits for a high award.

4. The right is reserved of withholding any or all premiums, in case no theses of sufficient absolute merit to deserve them shall be received. No thesis not deemed worthy of publication in full in Engineering News will be awarded any premium.

5. Except for special reason stated in the professors' certificates above referred to not more than three of the graduating theses of any one college shall be entered for the competition.

6. The right of first publication of all theses awarded premiums or honorable mention is reserved to Engineering News, and all theses receiving premiums will be so published.

7. No thesis which has been previously published in full or in substance will be eligible for the competition.

8. All theses competing for these prizes must be received by Mr. Collingwood on or before Aug. 1, 1893, and should be sent in as much earlier as possible.

9. The awards will be announced on or before Jan. 1, 1894, failing some special cause for further delay. All theses receiving neither premium nor mention will be returned by express to their authors. The manuscripts of the selected theses will belong to Engineering News, but the drawings will be returned after publication.

Circulars containing the above announcement have been mailed to every engineering school of which we have the address. If by any chance any college should fail to receive them, they will confer a great favor upon us by advising us of that fact and copies of the circular will at once be sent to them, and also to any person interested on request.

The proposed ship canal from the Great Lakes to the sea via the Erie Canal is an interesting topic from an engineering standpoint, but we seriously doubt that it will ever pass beyond the stage of press discussion. The Duluth Chamber of Commerce is agitating the construction of this canal by the national government; but, as against the alleged advantages of such a deep waterway we have yet to see any intelligent estimate of cost. As proposed, the scheme includes a ship canal around the Falls of Niagara, otherwise Lake Ontario would be cut off; the enlargement and deepening of the 360 miles of canal from Buffalo to Troy, and the deepening of the channel in the Hudson River for 80 or 100 miles and the maintenance of this channel. At a rough guess several hundred millions would be a low estimate for the accomplishment of this vast work.

The Duluth promoters figure that such a canal would save hundreds of millions annually by a reduction in freight, forced by canal competition with railways, and as a further incentive point out that Canada, with her nearly completed 14-ft. waterway, can send 150 English warships into the lakes in case of war. As to the saving of hundreds of millions annually in a reduction of freight rates, it might be mentioned that, according to the last report of the Interstate Commerce Commission, the net earnings of all the railways in the United States for the year ending June 30, 1891, was only $364,873,502, and the gross income from freight traffic was $736,793,699, or 67.17% of total earnings. This would mean that about $245,000,000 represented the total net earnings from freight for the entire railway system of the United States. This is a tidy sum of money; but it is not easy to see how all of this and more is to be saved by the building of the proposed canal. Canal competition has undoubtedly lowered railway rates, and will continue to do so; but with a ship canal costing as much as this one would, and in competition with railways for only seven months in the year, the general balance sheet would hardly be as favorable as the business men of Duluth would have it appear. As to the English gunboats, there is no immediate reason to fear such a hostile invasion. But did events unhappily point that way an army corps thrown across the frontier would be more efficient in protecting our lake cities from warships than any amount of ship canals across the state of New York. The soldiers would only have to stay long enough to blow up a few locks.

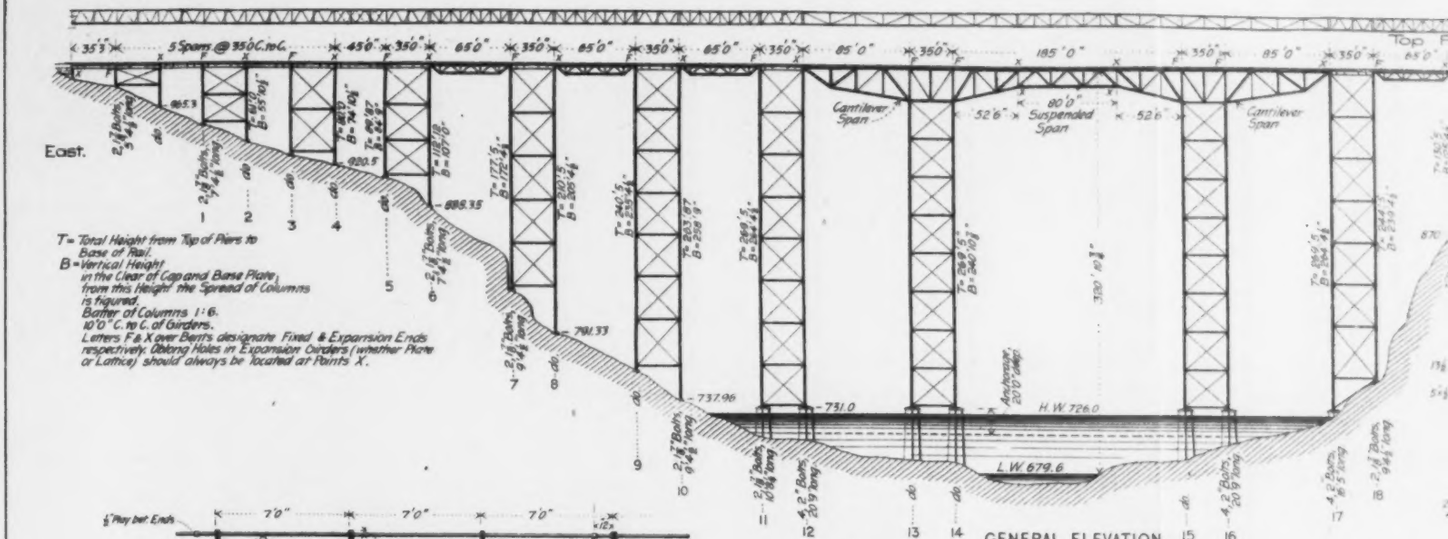
A more damning statement than that of the official "Liquidator" of the Panama Canal Co., made public last week, was surely never made, even without the heavy further allowances which that statement requires to get at the probable truth. It shows upon its face the following distribution of expenditures:

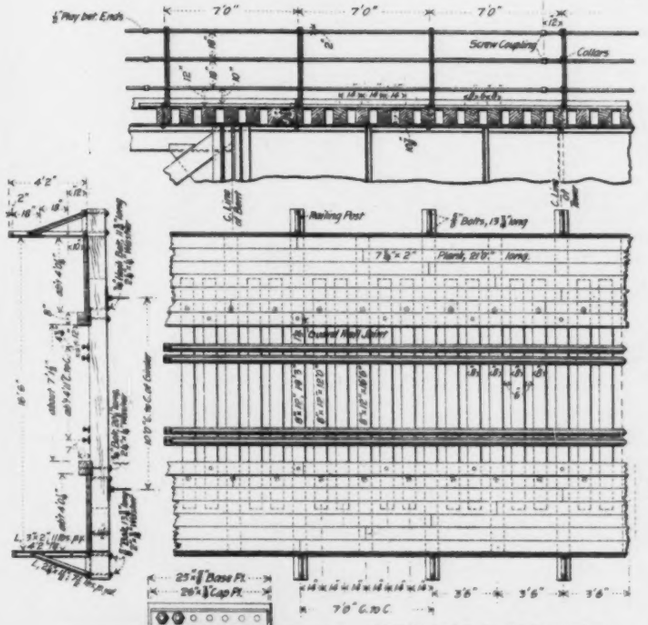
On the actual work of construction:

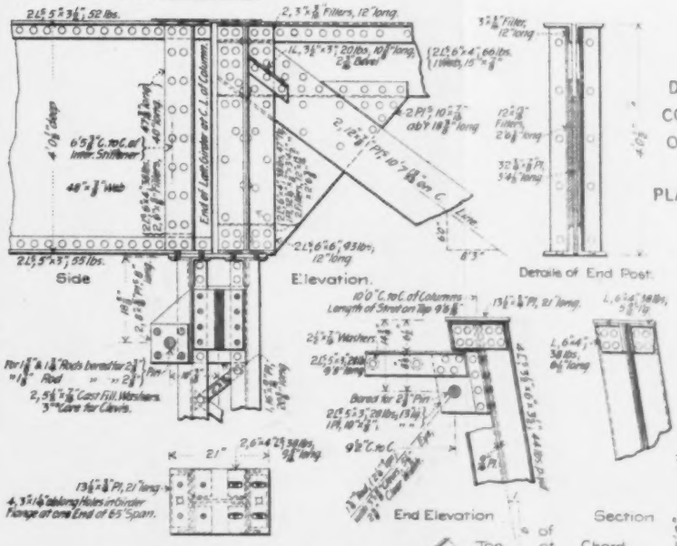
		P. c. of total.
1. Construction, materials and transport	$33,200,000	12.8
2. Contractors	88,600,000	34.0
3. Purchase Panama R. R.	18,600,000	7.3
Total on direct work of construction	$140,400,000	54.1
4. Paid to shareholders in interest and invested toward pay't. lottery bonds	$54,200,000	20.7
5. Preparatory work and organization	35,000,000	13.5
6. Concession and general expenses	12,800,000	4.9
7. Advertisements, taxes, etc.	17,600,000	6.8
Grand total	$260,000,000	100.0

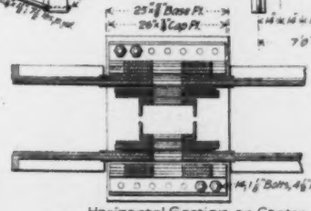
Here is a company which does not even profess to have expended but a little over half of the money raised in the actual work of construction; but of that half, much more than half again was wasted in the most profuse and absurd expenditures, and the most corrupt and reckless management of the work upon the Isthmus, so that the alleged $122,000,000 expended in actual construction does not, as outside limit, represent more than some $40,000,000 of actual work done and material on hand which would be useful to any succeeding company undertaking to carry through the work. All the rest was wasted in extravagant and corrupt contracts and in paying for the same work over and over again. For instance, we gave details as to one dredge which worked many weeks at one spot without moving, the sludge oozing back again into the canal as fast as it was dredged out. Millions of cubic yards at various points on the canal were thus paid for over and over again, while at other points, contractors having a lump price for rock and earth were permitted to skim the earth and then skip the rock. Add to this the $54,000,000, which has been or can be paid back to the stockholders, and a few millions more for miscellaneous assets,

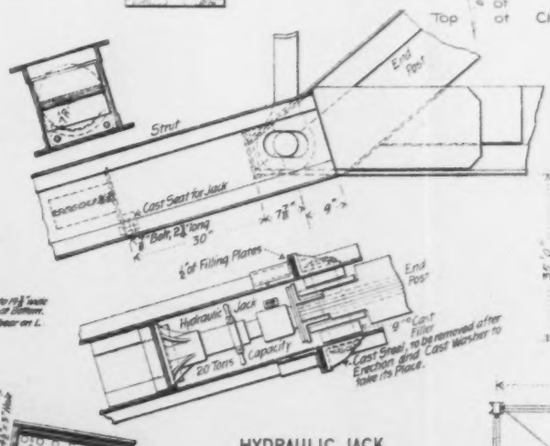
* The conditions of the award are given in full in Engineering News of Jan. 30, 1892. They were substantially the same as the competition for 1893, announced above.

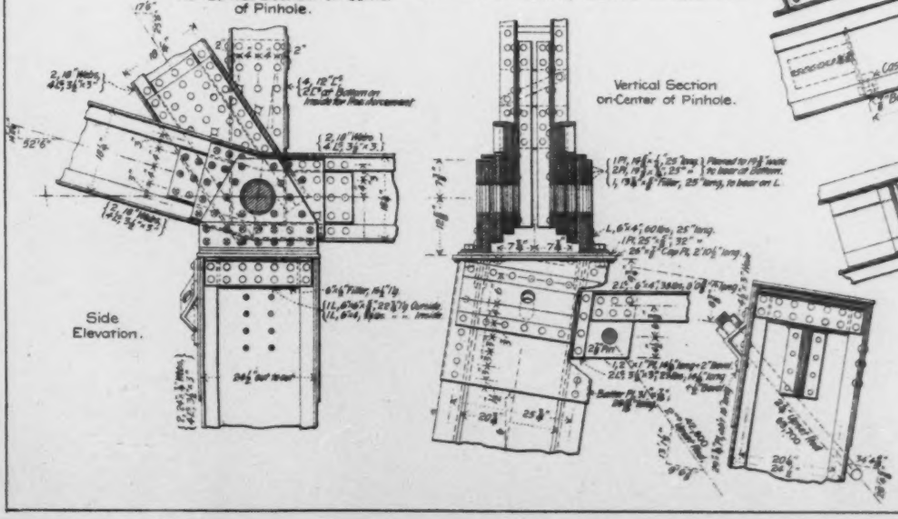

East.
5 Spans @ 350 C. to C.
450'
350'
65'0"
185'0"
85'0"
Cantilever Span
80'0" Suspended Span
52'6"
T = Total Height from Top of Piers to Base of Rail.
B = Vertical Height in the Clear of Cap and Base Plate; from this Height the Spread of Columns is figured.
Batter of Columns 1:6.
10'0" C. to C. of Girders.
Letters F & X over Bents designate Fixed & Expansion Ends respectively. Oblong Holes in Expansion Girders (whether Plate or Lattice) should always be located at Points 'X'.
H.W. 726.0
L.W. 679.6
GENERAL ELEVATION


Screw Coupling
Collars
Railing Post
Plank, 2'0" long
DETAILS OF FLOOR SYSTEM.

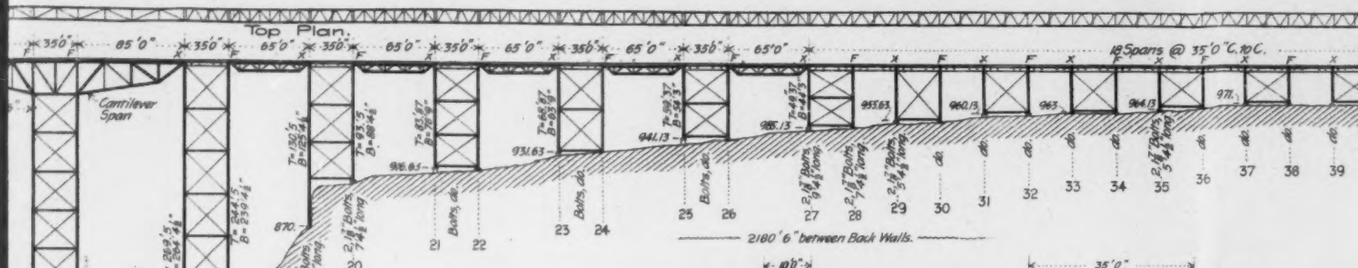

Side Elevation.
End Elevation
Details of End Post.
DETAILS OF CONNECTIONS OF LATTICE AND PLATE GIRDERS

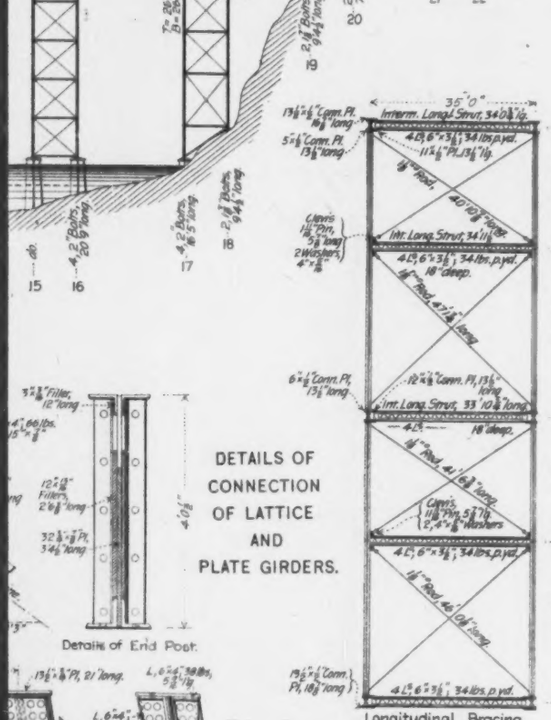

Horizontal Section on Center of Pinhole.
DETAILS OF PEDESTAL AND TOP OF COLUMN; BENTS 14 AND 15.


Strut
Cast Seat for Jack
Hydraulic Jack
20 Tons Capacity
HYDRAULIC JACK FOR ADJUSTING CONNECTIONS.

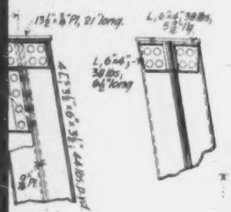

Side Elevation.
Vertical Section on Center of Pinhole.

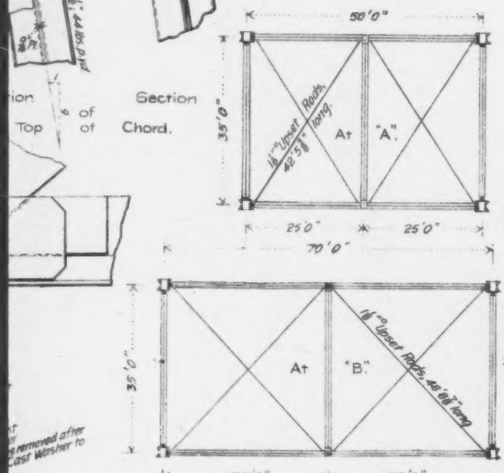
Top of Chord.
Section
44'10"

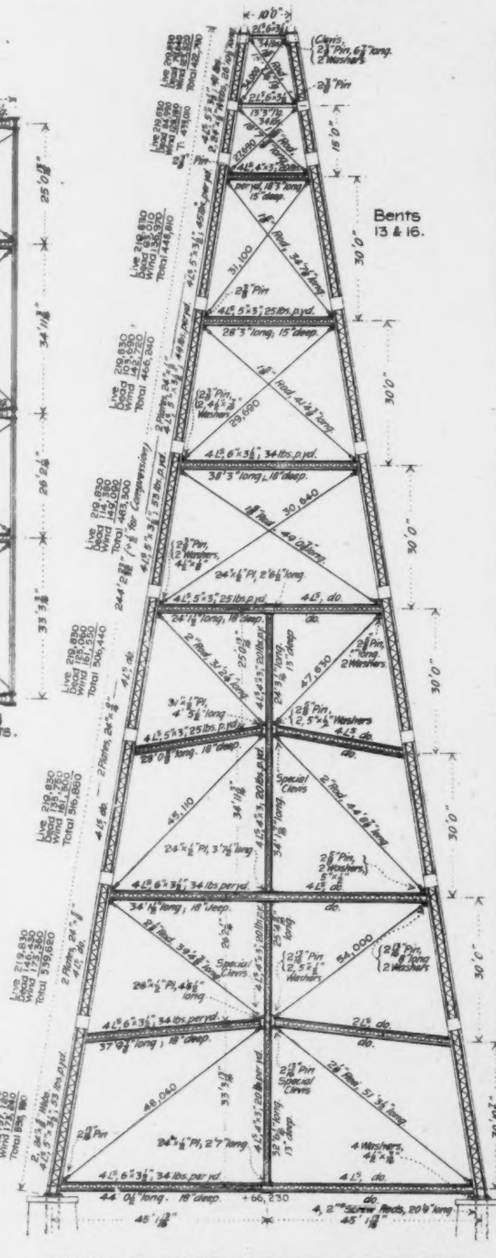



Interm. Longl. Strut, 34 0 1/2 lb.
Intr. Long. Strut, 34 11 lbs.
Intr. Long. Strut, 33 10 lbs. long
Longitudinal Bracing between Vertical Center Posts.

DETAILS OF CONNECTION OF LATTICE AND PLATE GIRDERS.





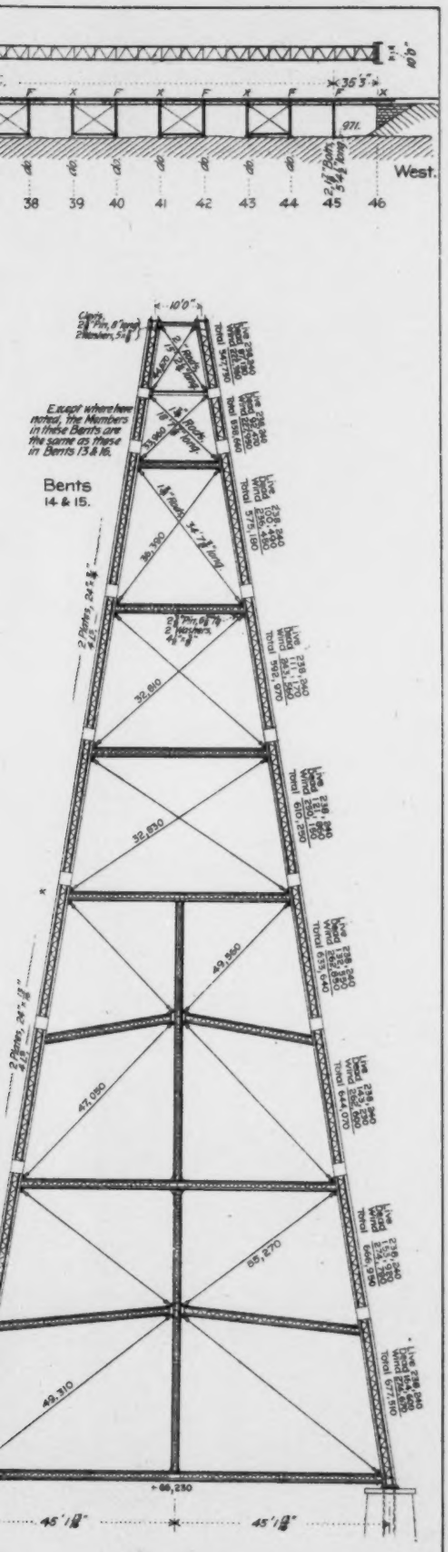


DETAILS OF TOWERS SUPPORTING CANTILEVERS.

PECOS RIVER VIADUCT; GALVESTON, HARRISBURG &

A. F. Bonzano, Chief Engineer, Phoenix Bridge Co. J. Kruttschnitt, Ch

Phoenix Bridge Co., Phoenixville, Pa., Contrac


West.
38 39 40 41 42 43 44 45 46
Except where here noted, the Members in these Bents are the same as those in Bents 13 & 16.
Bents 14 & 15.
45'1⅛"
45'1⅛"

URG & SAN ANTONIO RY.

hnitt, Chief Engineer. G., H. & S. A. Ry.

Contractors.

CHAS. HART & SONS, LITH, 39 VESEY ST., N. Y.

absurdly claimed as worth $14,000,000, and we have somewhat over $100,000,000—possibly $130,000,000—which can be accounted for as rationally and reasonably expended to advance the work to the point where it was when work was suspended or which has gone back somehow to the stockholders. All the rest, an even half, was dissipated by a mixture of Frenchy bad management and downright fraud—chiefly fraud.

The rapid transit sale resulted in precisely the fiasco which we predicted in our issue of Nov. 24, 1892, was "certain," viz., that "either there will be no bidder for the franchise (which is highly probable) or it will be knocked down for some paltry sum without real competition, leaving the buyer of the franchise complete master of the situation so far as the public interests are concerned, on the sole condition that he keep himself solid with the commission during the period of construction." There was no bona fide bid, the only bidder being an entirely irresponsible ex-employe of the commission who had been used to obtain the real estate "consents," and who was beyond reasonable doubt either bidding "on spec" or put forward to prevent the fiasco from being too ridiculous, and, above all, to give more color to the claim, which was promptly advanced, that the bid showed that the franchise was in itself unsalable, instead of showing, what it really did, that no one bidding in good faith on a business basis could bid at all under the absurd terms. The first bid was $500 cash and half of 1% of the gross receipts annually, which it was humorously urged would yield $50,000,000 to the city—in the course of 999 years!—at an estimated rate of $50,000 a year out of $10,000,000 annual gross receipts. This being rejected, another bid was offered by the same party, viz., $1,000 in cash, thus rating the present worth of the obligation to pay $50,000 per year to the city for 999 years, at only $500 cash in hand. The bidder doubtless made both of these offers with his tongue in his cheek; but some approach to this fearful ratio of difference between cash payments and contingent future obligations really exists in enterprises of this nature, as we pointed out in our former article, and, therefore, there could be no better illustration of the utter folly of offering such a franchise for sale at all for a sum in cash paid down. The nature of that offer alone, without considering the many other weak and objectionable features of the terms of sale, would indicate that either the commissioners were singularly incompetent, or that they had no expectation or desire to sell the underground franchise.

It now looks as if the latter were the case; for without waiting even to reconsider the situation for a day or two, or to try the effect of a new sale under more rational and defensible terms, the chairman of the commission gave out to the press, within three hours after the formalities of the sale were over, a long statement to the effect that "the failure is much regretted," that the commission's work had been "long and laborious," but that all the time it had taken was "well and necessarily occupied." He then went on to add, without any ifs or buts, that the commission had positively "offered the best, the most comprehensive, and withal the cheapest system that could be devised" (!), which shows that the commission thinks no small beer of itself, whatever others think of it. Nevertheless, in the very next line he admits with ludicrous haste that the commission "MUST immediately adopt other means," that "no underground system of rapid transit can be sold," and that "the streets must inevitably be invaded" by new elevated structures. Lest some natural suspicion of the sanity of the commission should arise from these inconsequential statements, he ends up with the cheerful and encouraging information that "the commission is now familiar with the entire subject in all its details" (!) and will "proceed with this work (of laying out elevated lines) at once." Thus ends as pitiful a case of juggling with an official trust as has been made in many a day by men above the grade of pot-house politicians. All signs concur to indicate that the commissioners are, consciously or unconsciously, mere puppets of some power behind the throne, which is working in a mysterious way its wonders to fulfill; and that those wonders are to be some new elevated lines, which can be sold out at a profit to the Manhattan company, or built by it.

The breakage of the screw shaft by three of the great transatlantic liners within a month must call renewed attention to the great advantages, as respects safety, of the twin-screw vessels. As we showed in our issues of Aug. 11 and 18, the single-screw vessel probably applies its engine power to its propulsion more effectively than the double or triple screw; but the great advantage as respects safety of having the whole machinery for the vessel's propulsion in duplicate are so great that the twin-screw vessel is doubtless the coming type for passenger service.

THESES IN ENGINEERING SCHOOLS.

As announced above, the prizes offered by Engineering News Publishing Co. for the best graduating theses presented by students of any engineering school in the United States or Canada in 1892 have been awarded. The thesis which has received the first prize is published elsewhere in this issue. While the subject investigated by the author of this thesis was in some respects less difficult than that chosen by others who took part in the competition, its practical importance, and the author's careful work in investigating and concise record of results, make it in many respects a paper to which an engineer of experience and standing in the profession might be proud to subscribe his name. The other prize theses, which we shall soon publish, also do much credit to their authors and are well worth a place in engineering literature.

We shall also find space as soon as possible for the publication (with some abbreviations) of the theses to which Honorable Mention has been awarded.

As announced in the original offer, these awards have been made by the editorial staff of Engineering News; but assistance has been rendered by experts in the examination of some of the theses. We acknowledge especially the opinions furnished us by Mr. Arthur Johnson, Chief Signal Engineer of the New York, Lake Erie & Western R. R., and by Mr. Chas. P. Steinmetz, M. Inst. Elec. E., of Yonkers, N. Y., as of great assistance to us in judging the theses.

The basis on which the awards have been made was, as stated in our issue of Jan. 30, 1892, as follows:

> The basis of selection for premiums will be the same as that used in selecting papers for publication in engineering journals or society proceedings; that is to say, theses will be graded according to their apparent permanent value for the advancement of engineering practice or theory, either as records of original research, or as intelligent and concise discussions or critical summaries of older researches; clearness, conciseness, and simplicity of form will be essential merits for a high award.

It will be seen that this is not quite the same basis as that on which the professors in an engineering school might grade the theses of their pupils. They can give credit for quantity of work as well as quality; and at some colleges at least the student gets credit for displaying in his thesis a proficiency in the subjects in which he has been trained. Neither of these considerations can have weight in judging theses from different colleges. In some schools much more prominence is given to thesis work than in others, and more time is allotted to it. The disadvantage in this competition of the students in schools which devote a short time to thesis work would be increased if mere length and quantity of work expended in a thesis' preparation were to count in its favor.

Doubtless the selected theses submitted to us were much more extensive and represented a greater amount of labor than the average "output" from graduating students; but after making allowances for this, we are still inclined to believe that too much time is being expended on thesis work in some of our engineering schools. This is especially true of that class of theses in which the student works out a design for some piece of engineering work, a bridge, for instance, and calculates strains, dimensions and weights of all its members. The amount of work done on some theses of this class submitted to us was enormous; and it is a question whether the student's time and energies might not be put to better use. The drill obtained in such work has some value, undeniably; but how much better for the student to spend the time in gaining a better knowledge of foundation principles or a knowledge of such neglected subjects as patent law, political economy, or in any of the many other directions in which he might study with profit. He had better gain a clear idea of how to do half a dozen different things than acquire great proficiency in performing only one. The shops of an engineering school are not meant to turn out blacksmiths and machinists, but to teach students the reasons which underlie the methods of work at forge and lathe. So the classroom had better develop the reason and judgment of the pupils than to let them spend too much time in mere routine calculations which do not tend especially to enlarge their mental horizon. Time spent on original experimental work stands on a different basis.

As examples of the tendency to slight the study of real problems, in one thesis submitted to us entitled "Design for a 149-ft. High Steel Skeleton of a Building" the author said: "Wind load will not be considered, as it very seldom is in Eastern practice." As the width of the building was only 48 ft., this calm disposal of wind strains was hardly satisfactory to the judges. Another student, in designing a system of sewers for a city of 50,000 inhabitants, limited the size of his smallest laterals to 12 ins. diameter, giving no reason whatever for so doing.

We call attention to these instances because they typify a very common defect, not only in college theses but in papers prepared by engineers for presentation before societies or publication in technical journals. Descriptions of structures, machines or processes too often leave the reasons which governed the designing engineer to the reader's imagination. The student who chose to design a sewerage system as his thesis work would have gained far more benefit and might have contributed a really valuable paper to engineering literature had he confined his thesis to reasons for fixing 12 ins. diameter as the minimum size of his laterals, answering at the same time to the best of his ability the arguments which would inevitably be brought up against such a limitation.

We call special attention to these facts because it has been suggested to us that theses on the design of a structure or theses which describe or criticise an existing structure stand no chance of obtaining a prize in this competition. We hold that this is not so, provided the student will prepare his thesis in the manner which will be of the greatest benefit to himself and which we have suggested above. A critical review of an existing piece of engineering work which shall show its faults as well as its merits and which shall show in detail the reasons which governed in its planning is truly a difficult sort of work for a student, but not more difficult, we believe, than some of the original investigations which form the subject of theses.

The thesis which stands third in the list of those receiving honorable mention is a "design" thesis, and a chief reason for making the award was that the author made a real study of his subject and set down the reasons governing his decision on various details. He inevitably made errors, many of them serious ones, as any engineer would, be he student or graduate, in his first attempt at work in such a difficult field as the design of signaling and interlocking plant. But the judges have considered these errors quite outweighed by the author's care in explaining in detail the reasons and principles which governed his work. We hope in this year's competition to receive more "design" theses of this class, and can assure their authors that such theses will stand on quite an equal plane will theses recording the results of original investigation.

Besides the "design" and "descriptive" and "original investigation" classes of theses, some examples of the "treatise" class have appeared in this year's competition. For example, one thesis submitted in competition for a prize had as a title "The Construction of Irrigation Works." The author began with the collection of irrigation water, and really prepared a creditable treatise on the subject of irrigation works, amounting to some 220 manuscript pages. Such an investigation of a broad subject, while it requires a large amount of time, is very profitable work for the student, especially if he has reason to expect that he will

make a specialty of the subject chosen. But in comparing such a thesis with others the fact must be taken into account that such work by a student is necessarily a compilation from existing literature, and the question must be considered, How great is the value of the compilation "for the advancement of engineering practice or theory?" It may be very great if the information given is widely scattered and not readily available. On the other hand, the student who attempts to write a thesis on a broad subject already well covered by able writers stands little chance of producing a valuable addition to engineering literature.

In our original offer of the prizes we requested the authorities of any college which decided not to permit its students to submit theses in this competition for any other reason than lack of merit, to report the fact to us in order that it might be definitely stated in the award that their graduates were so excluded, in justice to them. The Massachusetts Institute of Technology is the only institution which has given notice of such action, a principal reason given being that design theses were not likely to receive full justice in the awards. We hope the above discussion of the subject of design theses may induce a reconsideration of this decision for the present year's competition.

As announced above, the Engineering News Publishing Co. repeats its offer of prizes to students graduating in the year 1893 under practically the same conditions as those which governed the competition of 1892. The only change made in the conditions is that not more than three theses shall be sent in from any one college. Our experience this year convinces us that this will cover all the theses of exceptional merit produced by the graduating class of even the largest colleges. The amount of work which the careful examination of these theses by each member of the staff of this journal imposes, justifies us in requesting a preliminary editing to this extent by the professors at the various colleges.

The Ismid-Angora Railway, in Asia, is nearly completed, and recently the first locomotive was run over the line to Angora. The circumstance caused considerable stir and rejoicing among the population, which had flocked to the station. The completion of the line and the commencement of traffic will take place within the next two months. The railway was mentioned in our issue of Dec. 15.

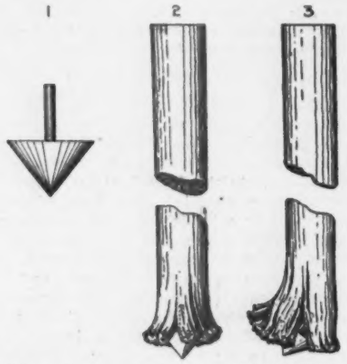
Extensive improvements are to be made on its lines by the Metropolitan Traction Co., which now controls practically the entire street railway system lying on the west side of the city of New York, including the Broadway cable road, now nearly completed, and many of the crosstown lines. These will comprise the introduction of cable power on the trunk lines, and electric power, either storage battery or underground conduit system, on the shorter lines, and new equipment. The new cars are to be lighted by electricity or gas and heated by warm water or steam. The company intends to introduce a very complete transfer system between its various lines.

The Brisbane Metropolitan Tramway Co., Brisbane, New South Wales, intends to substitute electricity for horse power, and the government has extended the time for compulsory purchase by the city. The administration of the Tramways Act has been transferred from the Minister for Works to the Minister for Railways. Under the Tramways Amending Act the Governor-in-Council has power to impose conditions with respect to the position of the wires of the electric tramways so as not to interfere with the working of the telegraph and telephone wires. The following conditions, which are based on those in force in the United States, have been recommended by the Postmaster-General, and have been approved: 1. Poles to be not less than 25 ft. in height, and so placed as not to interfere with telegraph poles or wires; 2. Poles to be not more than 130 ft. apart; 3. Supporting wires to be not less than 23 ft. above the street; 4. Conducting and trolley wires to be not less than 22 ft. above the street; 5. Conducting and trolley wires to be insulated so as to prevent the current being conveyed to the non-conducting poles or wires; 6. Proper precautions to prevent the falling of wires, also for protecting the trolley wires by steel guard wires not less than 6 ins. away, as a precaution against accident from the falling of telegraph, telephone or other wires; 7. Special arrangements to be made at crossings; 8. A second or return wire to be provided instead of using the earth as a return circuit; 9. The conducting wire to be carried at the opposite side of the respective streets or roads to that on which the telegraph or telephone lines are placed; 10. Each section to be provided with automatic devices for switching off at the power stations.

LETTERS TO THE EDITOR.

PILE DRIVING.

Sir: Noting your article and comments on pile driving in issue of Dec. 8, the following experience may be of interest to those of your readers who may be called upon to drive piles through cribwork and old timbers, such as I had occasion to do recently for the Department of Docks, at the foot of Canal St., North River, New York. The nature of the cribwork was unknown, and the quickest and best method of driving was determined by a series of tests as the work progressed. At first the piles were shod with cast iron shoes, as shown in Fig. 1, but failed, as shown in Figs. 2 and 3.



Effects of Driving Piles Having Cast-Iron Shoes.

The piles were next driven with the point cut off square, but broomed points and split and broomed heads appeared to such an extent that the method of pointing was resorted to with very favorable results. The piles used were sound and straight spruce and yellow pine sticks, the latter giving much better results, and withstanding the 60 to 70 blows of a 3,900-lb. hammer, falling 10 ft., much better than the spruce.

Eugene Lentilhon,
New York, N. Y., Dec. 14, 1892. J. Am. Soc. C. E.

Sir: In response to your invitation to discuss your "Suggested Code of Rules of Practice for Pile Driving and Safe Load of Piles" (Eng. News, Nov. 17, 1892), I ought, perhaps, simply to refer you to my discussion of Mr. Crowell's recent paper, in which I noticed at considerable length some of the points of which you now treat. I may, however, be permitted to repeat what I then intimated, viz., that "the elements attending the operation of the principles involved are so uncertain and so numerous, and the experimental data at hand are so uncertain and so few," that all rules upon the subject should (as my father observed of his own formula) be used with caution, and with a wide margin for safety in important cases.

Hence it seems to me a little hazardous to assert that the load given by your formula in par. 8 is "certainly safe under all conditions, except as below defined and limited," and that there is no experimental evidence to the contrary. The little collection of experimental data, which I submitted in discussing Mr. Crowell's paper, is vastly more complete than any other that I could find, and, in fact, embraces all such; yet those data are so few, so conflicting, and, in many cases, so uncertain, that I feel it would be quite within bounds to assert that there is no experimental evidence sufficient to confirm or to refute any formula. As you will see, your formula, in its approximation to the results quoted, compares favorably with the other two formulas then considered, yet we find that three of the four piles at Perth Amboy (my "case 4") settled with about 44,800 lbs. each. By your rule the safe load was 28,300 lbs. each. If these piles had been intended to support a wharf for the storage of grain, this would perhaps have been a sufficient margin of safety; but if they had been designed for a railroad trestle or for a tall factory with taller chimneys, and filled with rapidly running machinery and hundreds of operatives, a wider margin would have been desirable.

2. This, at least, emphasizes the criticism I have already made, that your formula in paragraph 8 is defective in that the factor of safety is made a fixed, not a variable, quantity. The second case given under Dordrecht (case 9) shows a nearly similar relation between the actual extreme load and the safe load as given by your formula. In other cases the safe load by the formula was greater than the actual extreme load, but the conditions of these cases were such that you would hardly consider them as coming within your limitations.

3. Under paragraph 10, I am disposed to ask: If the height of rebound must be deducted from that of the first fall, should not the fall from the rebound be taken into account, and its height be again added, restoring the height of fall to its original value, as though no "bounce" had occurred?

4. Under paragraph 23, I do not find it explained why we should assume that with one-tenth as great an interval between blows the initial resistance to driving "should not be over one-tenth as great, if so much." Indeed, referring again to my list of experimental data, I find that in the only two cases which we are, perhaps, warranted in taking as cases of steam-hammer driving, your formula, with divisor = S + 1, as originally given, comes much nearer to the experimental results than it does with the divisor, made = S + 0.1, as suggested in this paragraph. Thus, at Brooklyn (case 8) the extreme load was 224,000 lbs., and your formula for extreme load (with divisor = S + 1) gave 242,000 or 202,000, according to whether we take the penetration at 0 or 0.2 in., an exceedingly close agreement for pile driving data. But if we make the divisor S + 0.1, your formula gives extreme load 242,000 and 806,400 lbs. respectively. For Dordrecht (case 9) we have (or believe we have—see p. 156 of discussion) actual extreme load 13,440 lbs.; extreme loads by your formula with divisor = S + 1, 48,120 lbs.; with divisor = S + 0.1, 139,300 lbs.

5. This consideration confirms me in questioning the soundness of the reasoning by which you seek to demonstrate the logical correctness of the constant addition of 1 (common to your formula, and to ours), in the divisor, for all cases of driving with ordinary machines; for, by that reasoning, the quantity to be added to S ought, as you say, to be less for steam-hammer driving.

"Used with caution, and with a wide margin for safety," your code, I think, will serve a useful purpose; but I think, also, that, considering how much we don't know about the bearing power of piles, "presumably" is, "in all cases" connected with the subject, a better word to use than "certainly."

John C. Trautwine, Jr.

Philadelphia, Dec. 19, 1892.

(1. We are yet waiting for the first recorded instance where the formula proposed by us

$$\text{Safe load} = \frac{2\,w\,h}{s+1}$$

does not give a load which is "certainly safe" for a pile driver under conditions of good practice, or, indeed, under any conditions. There have been quite a number (chiefly of piles driven in mud) where a greater load would have been safe; none to the contrary. Opinions will differ as to what is "sufficient" to establish a formula. We consider that a formula shown theoretically to be consistent (i. e., rational) under all conditions, and shown practically to be inconsistent with no records, is amply established. The Perth Amboy record seems to us perfectly satisfactory. What better can be asked of a formula than to show a pile safe for 28,300 lbs., which actually fails under 44,800 lbs.? The assumption that this pile, which was safe for a wharf, might not have been safe under a factory is pure assumption.

2. There is no disputing about tastes. It is a weakness of our poor human nature to love to do its guessing under cover, so to speak; to like better to be told "here is a limit certainly unsafe; take such a slice as you, in your excellent judgment, may think best," instead of being told "this much is safe; you may sometimes go beyond it safely, but take a certain risk in doing so." Guesswork has its place, but its place is not in a formula; and it should always be recognized for what it is.

3. Of course not. The second blow is a second and distinct one; usually ineffective because too weak.

4. It is bad testing formulas by single cases, especially where there is so much room for doubt as to the real facts of the case, as in those cited.

5. Argument on this point is exhausted. It was not alleged that in every case of practice some change in the constant might not come nearer to the point for that particular pile, but only that these were of the nature of "errors of observation," liable to be either way, and that a constant should not be made a variable unless it could be varied intelligently and, for a specific reason stated, affecting that one constant and not the formula as a whole. If it is desired to make the formula variable, make it so directly by factoring the whole of it; and when it is nothing but guessing, make it a guess. Don't disguise it under a false pretence of precision, for the details of which no rational basis is claimed.—Ed.)

THE CITY WATER-WORKS BONDS OF ATHENS, GA.

Sir: I send a copy of a letter received by me from our lawyer in Georgia, as follows:

"Section 5191 of Georgia Code, which is a part of its Constitution, provides that before such bonds as are contemplated by the city of Athens are issued, the same shall be voted by two-thirds of the legal voters of said city.

"Under section 508L, the legislature undertakes to construe how it shall be ascertained what is the number of legal voters in a county or city. In such cases it provides that the tally sheet of the last election shall be taken as showing such number of legal voters. At the last general election prior to the bond election, there was registered in Athens 893 voters. There voted at that election only 310. There was no registration between that and the vote for bonds. You will remember that the vote for bonds was 448 in favor of bonds, and 4 against.

"In a recent case decided by our Supreme Court (Gatins vs. Atlanta, 86 Ga., 132) it was held that section 508L could only apply as interpreting the Constitution where there was no better way, and that where there was a registration, the registration should be taken as showing the number of legal voters in the city instead of the tally sheets, as mentioned in said section."

This makes the bonds of no legal force. We understand that though the mayor and council have had notice of this they are trying to dispose of the bonds.

W. H. Howell,
Secy. New York Water Supply Co., formerly Athens City Water-Works Co.
N. Y., Dec. 6, 1892.

(A copy of the above letter was sent to the mayor of Athens in order that the city's view regarding the validity of the bonds might be presented.

The mayor's reply is given below, and those interested may draw their own conclusions. The company's works were built in 1882-3, and the Athens City Water-Works Co. was reorganized under its present name and under a charter granted by another state, after the city decided to build works. It was reported at the time that the reorganization was effected to insure the possibility of carrying the questions involved into the United States Courts. The mayor's letter is as follows. —Ed.)

Sir: Your favor of the 16th inst. to hand, inclosing copy of communication of W. H. Howell, attacking the validity of our city water-works bonds. I certainly appreciate and thank you for your kindness in offering to publish the city's side of the question along with Howell's attack. But I must decline to do so, for the reason that we have sold the bonds, and have already furnished purchaser with all necessary information and data showing the validity of our bonds to any impartial mind. Having sold the bonds and done our duty by the purchaser, I must decline any controversy with the said Howell. The bonds were sold to the Atlanta Trust & Banking Co., of Atlanta, Ga. The work has already begun on the new system. The contractors are Neely & Co., Chattanooga, Tenn.

The city's reason for building new water-works, a system of its own, was the utter failure of the old system, of which Howell is President, to furnish a proper and adequate water supply for the city. We understand perfectly well Howell's business in attacking our bonds. He knows that his system "has been weighed in the balance, and found wanting," and that its days are numbered, hence his kicking. We can afford it. Let him "kick on." Again thanking you for your kindness, I am yours truly,

Henry C. Tuck,
Athens, Ga., Dec. 19, 1892. Mayor.

(Since the above was put in type an injunction suit has been brought against the city, evidently in the interests of the company, to prevent the issue of the bonds. The court dissolved the injunction, and it is said that the case will be carried to the State Supreme Court.—Ed.)

THE COMPARATIVE ECONOMY OF HIGH DUTY PUMPING ENGINES.

Sir: The article in your issue of Dec. 22, comparing different types of pumping engines seems to have caused wide and interesting comment, although, as might be expected, indicating some varying opinions. The march of improvement and refinement in pumping machinery is resistless and inevitable; but the engineer is held back somewhat by the limit of price that the buyers will pay. Also, the battle of competition is as ingeniously and desperately fought as that of any real army in the field, the average individual called upon to decide the matter being hopelessly befogged at times by the newness and depth of the controversy in which he finds himself involved.

Your article is in the right direction, and cannot fail to awaken interest and investigation upon a broad plane. I notice comments upon the article, unsigned, but can read between the lines, the "fine Italian hand," of one who once said that "people will not pay for the best that the engineer can do."

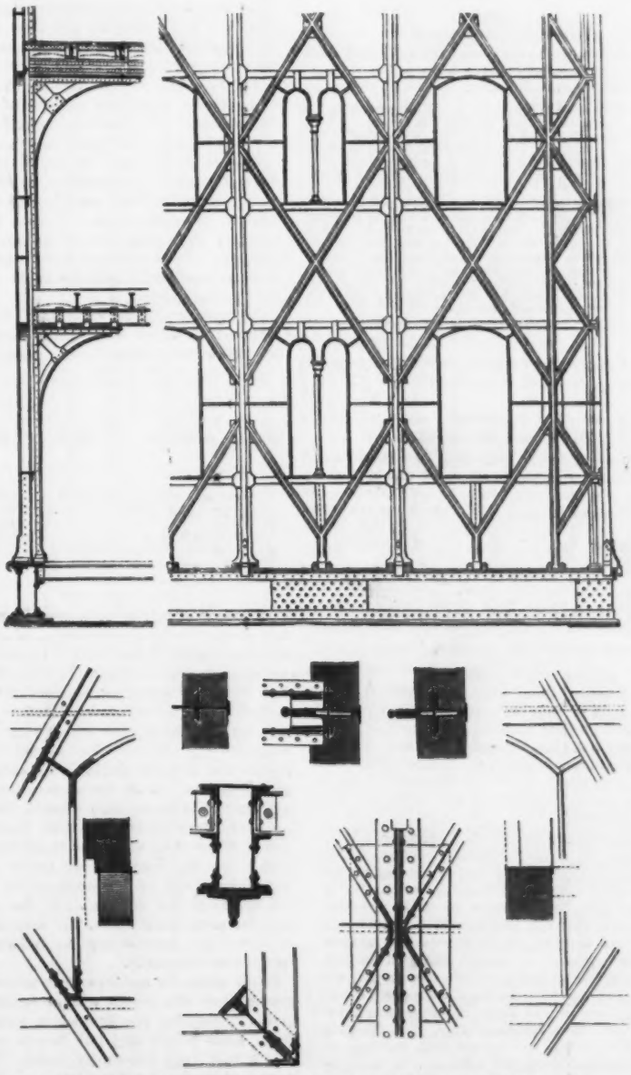
When Gilbert & Sullivan gave to the world the song about making "the punishment fit the crime," they builded better than they knew

Very respectfully,
New York, Dec. 26, 1892. Chas. A. Hague.

THE ORIGINATOR OF THE SKELETON TYPE OF HIGH BUILDINGS.

Sir: A short reference to patents for skeleton buildings in the last issue of Engineering News directs my attention to the originator of this type of structure, which is supposed and even claimed to be an American invention.

As far back as 1873 the idea of iron skeleton buildings was broached and carried out by Architect Saulnier in the construction of the chocolate factory of Menier, at Noisiel-sur-Marne (France), a description of which



TYPE OF IRON SKELETON BUILDING ERECTED IN FRANCE, 1873.

can be found in the "Encyclopedie d'Architecture," of 1874 and in the "Deutsche Bauzeitung" of 1878.

The building, which consists of three stories with an iron roof, is erected on four masonry piers in the River Marne, between which piers are placed hydraulic motors (turbines), in such a way that a direct transmission of power to the building is accomplished. An iron floor frame, composed of four longitudinal box girders over the piers, and two end cross girders of the same depth (28 ins.), support the outer walls and two interior rows of columns.

The verticals and diagonals of the skeleton framework are H-section of unequal flanges with the narrow flange turned outside. The exterior veneer consists of hollow bricks, 11 cm. thick, laid flat, and arranged in a great variety of patterns with different colors.

Yours truly,
Pittsburg, Pa., Dec. 18, 1892. J. Deforth.

(We reproduce from the "Deutsche Bauzeitung" of July 10, 1878, the cuts referred to by our correspondent. This building belongs without doubt to the type of skeleton structures now so popular, and until Americans can show an earlier example of actual construction, the honor of the suggestions at least must belong to the architect Saulnier.—Ed.)

THE BROOKLYN BRIDGE QUESTION.

Sir: I note the following in the "Telegram" of Dec. 15:

Electricity is to be used as a motive power on the Brooklyn Bridge as soon as arrangements can be perfected, according to President Howell.

The same paper, two days later, gives some suggestions from a "Prophetic Taxpayer," as to there being some "nigger in the fence," which I inclose. It might be said, supplemental to this prophecy, that the change of motive power from cable traction to electricity is the only way by which the bridge officials can escape the responsibility of putting their own plans of "tail switching" into use, which they have stated was their preference over a "loop" system, which it is thought was first recommended to them by you.

New York, Dec. 22, 1892. Engineer.

WHERE IS THE STUMP?

Sir: My friend Mr. Heller has just shown me the communication from which I make the inclosed copy for the edification of the profession at this festive sea-

son. For obvious reasons, and at Mr. Heller's request, I have suppressed the signature, but if any of your correspondents can give the location of the required stump, I shall take pleasure in passing it along to this anxious inquirer, who will thus be spared the cost of preparing the mineral rod. Yours truly,

John C. Trautwine, Jr.

Philadelphia, Dec. 22, 1892.

Mrrs Haler & Brightely

Do you make any thing in the Shape of a mineral Rod that will Draw to gold & Silver I know whare there is 18000.00 Dolars in gold buried 10 steps from a stump but canot find the stump if you will Bore a hole into a Peace of Steel 7 in long & Put a Bottel half full of quick silver & then Magtnise it & Put it on a Rod of Apple tree or Ratan or Whale Bon or if you fix it on a leaver on Center it will draw to gold & silver if you will send me a Peace of steal I inch in Diameter I will make one & send it to you to Put the quick silver & magnetise it or if you know of any one that makes them send the adres you will find an envelope for return Letter

Send Price of steal & I will send you the money

Adress

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ENGINEERING ETHICS.

Sir: I think so much of the inclosed rules laid down in your issue of Nov. 10 that I have added them to the Ten Commandments. Thus:

11. THOU SHALT NOT accept a call in consultation for any work which is already in charge of an engineer, except the call come from or through such engineer in charge. Engagements tendered from principals should be considered or accepted only when there is no engineer already in charge of the work.
12. THOU SHALT NOT report upon any work which is already in charge of an engineer, except to such engineer in charge. Reports to principals direct shall only be made when there is no engineer in charge; nor then, when there has been an engineer in charge whose professional acts are impeached in such report, without prior tender of a copy of such parts of the report as may personally concern him, for his perusal and response.

Yours truly, with thanks,

A. D. Ottewell.

(We would that every other reader of this journal would straightway do likewise.—Ed.)

THE WIDTH OF THE PROPOSED NEW WATER-WORKS CONDUIT FOR ROCHESTER, N. Y.

Sir: Permit me to correct statement in your note on page 553 (Dec. 15), relating to width of the Rochester Water-Works conduit. The width is definitely stated in the advertisement on page XIX, where we read, "6 to 6½ ft. high and wide inside." Yours very truly,

Rochester, N. Y., Dec. 17, 1892. E. Kuichling.

(The official advertisements, in referring to dimensions, are punctuated to read, "from 6 to 6½ft. high, and wide inside." The extra comma gave us the impression that the width had been omitted by mistake.—Ed.)

NOTES AND QUERIES.

W. C. B., Toronto, Can., asks for information regarding the length of time an ordinary rubber packing will last, such a packing as is used in the foot-valves of pumping engines, for example. He says he has known a rubber-gasket between the flanges of a 36-in. pipe, laid in fresh water, to last 17 years in a conduit of the Toronto water-works, and it was in perfect condition when removed.

O. E., of Brooklyn, asks whether masonry laid in freezing weather in 2 to 1 Portland cement mortar mixed with a solution of salt, is just as good as similar masonry laid under ordinary circumstances? As far as our experience goes, the mortar in such masonry, even when mixed with salt water, will usually freeze solid and will then thaw out on the approach of warmer weather. If the masonry is coursed and well backed, this thawing may do no harm, as the mortar will set hard again. The danger lies in the thawing out bringing strains on the masonry from the superincumbent weight acting on the softened mortar, and cracking may result. We would not advise the building of high rubble masonry piers, for example, in freezing weather. Cracking will very generally follow, and in thin brick walls the thawing of the mortar on the face will cause bending outward.

H. J. A., of Lawrence, Kan., asks concerning the method of ascertaining the fact of an adequate and permanent supply of ground water on a large scale. We know of no reliable method other than the following: Ascertain the area of the permeable soil, or sand and gravel, and the flow of the streams or lakes which might feed this area. To find that quantity of water that may be relied upon we know of no method so certain as the sinking of a few gang-wells and continuous, forced pumping for a considerable length of time. Test-tubes should be driven for some distance about the well and soundings made to ascertain the effect of the pumping on the stored underground water. If there are no direct feeders to the ground water supply, you can depend only upon about 60% of the annual rainfall, which, with say 42 ins. of rain, would amount to about 1,200,000 gallons daily per square mile of permeable soil. As a rule, the chief feeder of underground waters is the rainfall, because the bottoms of streams and lakes are liable to silt up in the course of time when any unusual draft is made upon them. Filter galleries alongside streams generally decrease in their annual yield even in good, porous soil.

INVESTIGATION AS TO THE EFFECT OF RETEMPERING UPON THE STRENGTH OF CEMENT MORTARS.

By L. H. Goddard, Dunham, O., and P. P. Evans, Chillicothe, O., graduates in the class of 1892, Ohio State University.

It is the common practice upon engineering works where large amounts of cement mortar are used, to temper the mortar after it has acquired its initial set. Very frequently a large bed of mortar is mixed in the morning and kept stirred up all day. Contractors and some cement men claim that this does not injure the strength of the cement, and brick masons much prefer this tempered mortar to that freshly made, on account of its greater ease of working. Engineers and inspectors claim that the strength is very much reduced by the process.

The following sets of experiments were made with a view of determining whether the strength was impaired by the resetting of the cement. Six brands, four Portland and two Rosendale, were selected as representative brands sold upon the market. These cements were bought from retail dealers, and hence are the same quality as those sold to customers.

Experiments were conducted in the following manner: A batch of mortar, enough to make 11 briquettes, was mixed in the morning to about the consistency of mortar as is used in practice and was left upon a clean glass plate. At intervals during the day the batch was stirred up and enough water added each time to make the cement soft and plastic. With quick-setting cements the mortar would sometimes be set rather hard before the first breaking, but afterward they would very rarely attain a complete set before the second breaking. The immediate activity would in all cases be considerably lessened. With the slow-setting cements, the mortar would in no case receive its full set. The mortars were treated in this manner for eight hours, when they were put in molds and left over night. In the majority of cases the briquettes would have set hard enough to be removed from the molds in the morning. At the same time the parallel tests were made, the mortars were mixed to the same consistency as before and put directly into the molds.

In all cases the mortars were mixed by hand and pressed into the molds with a small trowel. The molds containing the briquettes were placed upon clean glass plates and put into a box, the air of which was kept constantly moist. The briquettes were left in this box for 24 hours, when they were taken out and packed in shallow pans containing water. They were left here until the time of breaking.

The ages of the briquettes broken were respectively 7 days, 28 days, 56 days and 84 days. The briquettes were broken upon a Tinius Olsen & Co. machine, which gave 65% good breaks out of 2,000 briquettes.

All cements were tested neat and with sand. In the case of the Portland cements the sand was in the proportion of 3 parts by weight of sand to 1 of cement; and in the case of the Rosendales, 1 part of sand to 1 of cement. A clean sharp sand was used. Only that part was used which would pass through a No. 20 sieve and be caught upon a No. 30 sieve.

Besides the above experiments, tests for fineness, activity and weight were made. For fineness a sieve containing 2,600 meshes per sq. in. was used. It was marked as a No. 60 (3,600 per sq. in.) but calibrated only No. 51 (2,600 meshes per sq. in.)

The tests for activity were those recommended by Gen. Gilsmore. A stiff pat of neat cement about ½ in. thick was mixed up and placed immediately in water. The time elapsing until it would just bear a wire 1-12 in. in diameter, loaded with ¼ lb., was noted; and also the time until it would just bear a wire 1-24 in. in diameter, loaded to 1 lb. In the former case it was called "began to set," and in the latter "fully set."

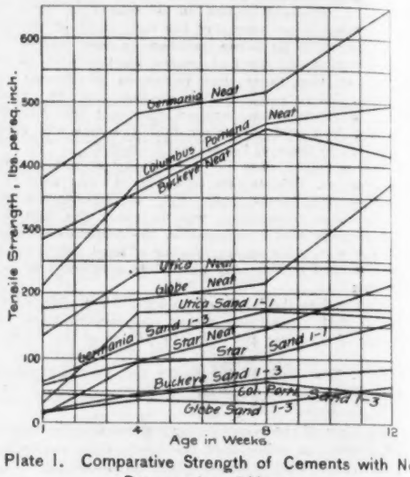


Plate I. Comparative Strength of Cements with No Retempering of Mortar.

Table 1.—Description of the Cements Used.

No.	Name.	Kind.	Manufactured at	Weight per cu. ft.	Color.	Per cent. retained in 51 sieve.	Activity. Began to set.		Fully set.	
				Lbs.			Hrs.	Min.	Hrs.	Min.
1	Germania	Portland	Germany	77⅝	Gray	0.15	7	20	14	20
2	Globe	"	Belgium	70	Blue Gray	4.49	6	40	8	35
3	Buckeye	"	Bellefontaine, O.	81⅛	Sepia Gray	4.60	1	42	1	22
4	Col. Portland	"	Columbus, O.		Light Gray	7.14	0	25	0	30
5	Louisville Star	Rosendale	Louisville, Ky.	58⅞	Yellow Gray	12.87	0	27	0	52
6	Utica	"	Utica, Ill.	55⅛	Light Yellow	24.00	2	10	6	15

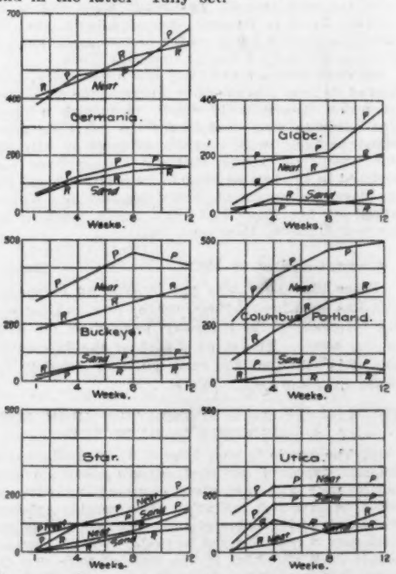


Plate II Effect of Resetting on Strength of Each Cement

For weight an apparatus was so made that the cement could be sifted and allowed to fall an average distance of 3 ft. into a box containing 1-10 cu.

ft. This box was "struck off" level and the contents were weighed.

The cements were also analyzed in the mining department of the university. The room in which the experiments were made was kept at a constant temperature of about 70° F., and the water at the temperature of the room.

Plate I. is a set of curves showing the strength of the different cements, neat and with sand. These

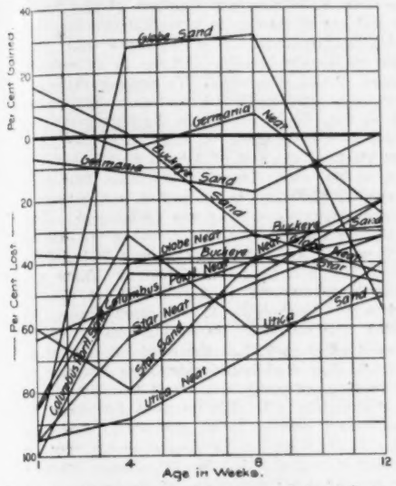


Plate III. Percentages of Loss and Gain of Strength of Each Cement Due to Resetting.

strengths are the "parallel" strengths. The mortars were mixed and put directly into the molds without any initial set being broken. The values were taken directly from Table III.

Plate II. gives curves for each cement, showing effect of resetting on the strength both when mixed neat and with sand.

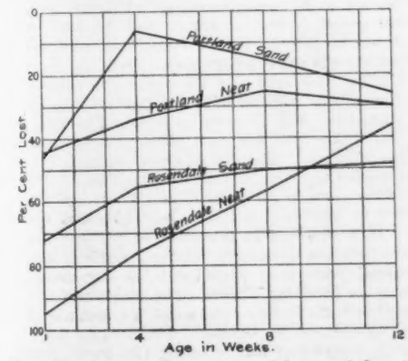


Plate IV. Average Percentages of Loss and Gain by Resetting of the Portland Cements and of the Rosendale Cements.

Plate III. is a set of curves showing the percentages lost or gained by each cement by resetting. The values are taken from Table III.

Plate IV. is a set of curves showing the average percentages of losses and gains by resetting for Portland cement, neat and with sand; and Rosendale cement, neat and with sand.

Table II.—Chemical Composition of the Cements.

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.
SiO_2	23.27	28.25	23.79	20.96	26.35	26.21
Al_2O_3	7.07	7.32	7.69	9.25	5.53	4.18
Fe_2O_3	1.64	1.43	1.54	1.23	1.12	1.36
CaO	63.34	51.72	56.18	58.25	47.30	31.68
MgO	1.12	2 48	3.22	5.08	9 05	20.02
K_2O	0.28	0.78	2.42	0.58	1 68	1.03
Na_2O	0.31	0.45	0.00	0.45	0.06	0.42
Loss by ignition	1.45	3.17	1.88	1.78	4.09	12.33

From Tables IV. and V., Plate V. is made. The relative rank, as regards ability to stand resetting, of the different cements (in the order used in the preceding table) are placed in a column on the left. At the right are placed the relative rank as regards activity, fineness, amounts of silica, alumina, oxide of iron, oxide of lime, oxide of magnesium, and the alkalies.

In all cases except one the cement having the largest amount of any chemical is ranked 1; the next, 2; and so on. In Fig. 9 the order is reversed and the cement having the least oxide of magnesium is ranked 1; the next, 2; and on. Lines are drawn joining the ranks, which help to prove the existence or non-existence of laws. The resetting ranks are the neat ranks, except where otherwise labeled. The reasons for this were because the tests for activity were made with neat cement and the chemical analyses were made of the neat cements.

From the plates and tables a number of conclusions can be reached. These conclusions are made general but must not be considered absolute, on account of the small number of cements used. Had a larger number of cements been used, more absolute conclusions could have been reached.

From Plates III. and IV. it is seen that in all cases the strength of the cements is decreased by resetting. The Rosendales are affected to a greater extent than the Portland. The former appear to regain their strengths in a faster ratio than the latter. The Portland cements lost 45% at the end of seven days, 20% at the end of 28 days, 20% at the end of 56 days, and 28% at the end of 84 days; while the Rosendales lost 83% at the end of seven days, 65% at the end of 28 days, 54% at the end of 56 days, and 42% at the end of 84 days.

Table III.—Results of Tensile Tests of Briquettes.

Cement.	Kind of Test: R=Resetting P=Parallel to resetting.	Age of Briquette, days.	Comp. of mortar. Cement	Comp. of mortar. Sand.	Results from breaking 10 briquettes; strength—lbs. per sq. in. Max.	Mean.	Min.	Av. loss or gain by resetting. Loss.	Gain.	Good breaks.
								%	%	%
Germania	R	84	1	0	600	491.4	390	21.5	....	10
	P	84	1	0	730	648.9	615	.....	....	22
	R	84	1	3	186	163.4	135	.....	0.2	100
	P	84	1	3	185	166.0	115	.....	....	60
	R	56	1	0	632	552.6	474	...	7.1	30
	P	56	1	0	665	515.8	390	.....	....	60
	R	56	1	3	185	142.9	110	17.7	....	43
	P	56	1	3	195	173.5	145	.....	....	70
	R	28	1	0	580	467.0	370	4.2	....	40
	P	28	1	0	549	482.3	452	.....	....	40
	R	28	1	3	140	110.8	97	11 3	....	60
	P	28	1	3	169	124.9	97	.....	....	90
	R	7	1	0	514	406.8	238	.....	7.1	40
	P	7	1	0	442	380.0	310	.....	....	40
	R	7	1	3	90	58.8	44	6.8	....	70
	P	7	1	3	91	63.1	46	.....	....	60
Buckeye	R	84	1	0	394	332.7	261	20.1	...	30
	P	84	1	0	488	416.6	336	.....	....	30
	R	84	1	3	78	61.6	49	28.7	....	80
	P	84	1	3	101	86.4	70	.....	....	100
	R	56	1	0	402	281 7	225	38.6	..	30
	P	56	1	0	553	458.4	406	.....	....	60
	R	56	1	3	62	47.5	40	31.7	....	60
	P	56	1	3	90	69.5	56	.....	....	60
	R	28	1	0	260	230.2	175	38.6	....	70
	P	28	1	0	469	358.5	257	.....	....	70
	R	28	1	3	58	49.9	38	.....	1.0	70
	P	28	1	3	57	45.4	39	.....	....	60
	R	7	1	0	204	179.2	150	36.7	....	70
	P	7	1	0	335	283.3	242	.....	....	70
	R	7	1	3	24	18 1	12	.....	16.0	60
	P	7	1	3	25	15.6	10	.....	....	22
Globe	R	84	1	0	248	210.0	179	43 6	....	70
	P	84	1	0	450	372.0	320	.....	....	50
	R	84	1	3	43	26.0	15	55.4	....	70
	P	84	1	3	68	58.3	49	.....	....	60
	R	56	1	0	197	149.0	137	31.2	...	30
	P	56	1	0	275	216.5	160	.....	....	40
	R	56	1	3	46	40.9	39	.....	31.5	38
	P	56	1	3	46	31.1	23	.....	....	90
	R	28	1	0	134	113.8	90	40.0	....	40
	P	28	1	0	223	189 4	170	...	....	60
	R	28	1	3	60	46.4	30	.....	27.8	100
	P	28	1	3	55	36.3	20	.....	....	60
	R	7	1	0	33	25.2	15	85.3	....	40
	P	7	1	0	200	172 4	137	.....	....	60
	R	7	1	3	2	0.8	0	94.3	...	40
	P	7	1	3	18	14.1	10	.....	....	67
Col. Portland.	R	84	1	0	380	338.0	280	31.9	...	30
	P	84	1	0	565	496.1	435	.....	....	78
	R	84	1	3	42	35.4	22	20.3	....	70
	P	84	1	3	54	44.4	35	.....	....	90
	R	56	1	0	312	284.3	215	39.1	....	44
	P	56	1	0	543	467.2	405	.....	....	60
	R	56	1	3	45	35.5	27	44.2	....	90
	P	56	1	3	74	63.6	49	.....	....	90
	R	28	1	0	215	177.8	146	52.4	....	80
	P	28	1	0	445	374.3	305	.....	....	80
	R	28	1	3	38	23.9	18	43.0	....	80
	P	28	1	3	48	41.9	36	.....	....	70
	R	7	1	0	87	76.6	65	63.5	....	90
	P	7	1	0	245	210.2	172	.....	....	90
	R	7	1	3	0	0.0	0	100.0	....	100
	P	7	1	3	52	44.2	37	.....	....	60
Louis. Star.	R	84	1	0	180	146 8	115	31.8	....	20
	P	84	1	0	228	215.3	175	.....	....	40
	R	84	1	1	96	83.5	73	46.4	....	70
	P	84	1	1	182	155.7	116	.....	....	80
	R	56	1	0	115	77.4	58	46.1	....	90
	P	56	1	0	175	143.6	115	.....	..	60
	R	56	1	1	105	63.9	43	38.4	....	100
	P	56	1	1	115	103.8	83	.....	....	100
	R	28	1	0	45	35.5	25	62.7	....	100
	P	28	1	0	112	95.1	80	.....	....	70
	R	28	1	1	40	19.5	9	79.5	....	50
	P	28	1	1	105	95.0	81	.....	....	60
	R	7	1	0	8	3.0	0	94.9	....	40
	P	7	1	0	92	58.5	30	.....	....	70
	R	7	1	1	7	4.9	3	60.0	....	80
	P	7	1	1	25	12.2	6	.....	....	90
Utica.	R	84	1	0	187	143.8	102	40.0	....	70
	P	84	1	0	270	239.6	215	.....	..	80
	R	84	1	1	107	87.3	70	50.8	..	100
	P	84	1	1	215	177.4	163	.....	....	100
	R	56	1	0	98	77.4	50	67 6	....	80
	P	56	1	0	265	239.2	215	.....	....	40
	R	56	1	1	79	66.3	53	62.1	....	60
	P	56	1	1	197	175.0	150	.....	....	80
	R	28	1	0	34	26.8	21	88.4	....	50
	P	28	1	0	274	231.0	190	.....	....	40
	R	28	1	1	138	117.3	106	31.1	....	80
	P	28	1	1	203	179.1	160	.....	....	80
	R	7	1	0	13	7.1	4	94.7	....	100
	P	7	1	0	150	134.3	114	.....	....	50
	R	7	1	1	8	4.9	3	84.1	....	100
	P	7	1	1	40	30.8	25	.....	....	70

Table IV.—Relative Rank of the Different Cements as Regards Activity, Fineness and Ability to Stand Resetting.

Cement.	Resetting. Neat. Days. 7	28	56	84	Sum.	Resetting. Sand. Days. 7	28	56	84	Sum	Activity. Began to Set.	Activity. Fully Set.	Fineness.
Germania	1	1	1	2	5 (1)	2	3	2	1	8 (1)	6	6	1
Globe	4	3	2	5	14 (4)	5	1	1	6	13 (3)	5	5	2
Buckeye	2	2	3	1	8 (2)	1	2	3	3	9 (2)	3	2	3
Col. Port	3	4	3	3	13 (3)	6	5	5	2	18 (5)	1	1	4
Louisville	5	5	4	3	17 (5)	3	6	4	4	17 (4)	2	3	5
Utica	5	6	5	4	20 (6)	4	4	6	5	19 (6)	4	4	6

In both cases the mortars of sand and cement lost less of their strength than the neat.

The Rosendale cements kept on regaining their strength as far as the experiments have gone, while the Portlands were losing at the end.

Table V.—Relative Rank of the Different Cements as Regards the Amounts of Silicates, Iron, Alkalies, Etc.

Cement.	S_1O_2	AL_2C_3	FE_2O_3	CAO	MGO	Alkalies.
Germania	5	4	1	1	6	6
Globe	1	2	3	4	5	4
Buckeye	4	3	2	3	4	1
Col. Port	6	1	5	2	3	5
Louisville	2	5	6	5	2	2
Utica	3	6	4	6	1	3

Figs. 1 and 2 show that there is no law connecting activity and ability to stand resetting.

Figs. 3 and 4 show that the finer the cement, the less it is affected by the resetting process.

Fig. 5 shows that the amount of silica does not affect the resetting properties.

Fig. 6 shows that the less alumina the cement contains, the more it is affected.

Fig. 7 shows that there is no law connecting the amount of oxide of iron and the ability to stand resetting.

Fig. 8 shows that the more oxide of lime a comment contains the less it is affected.

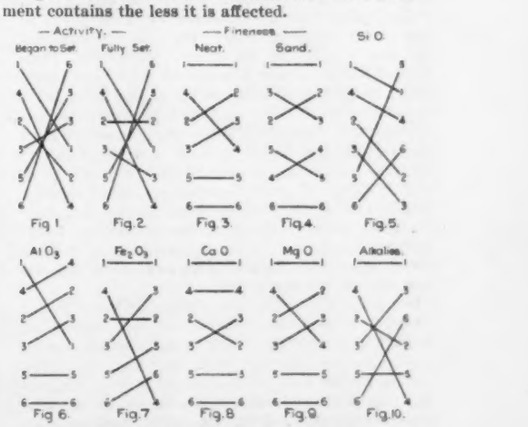


Plate V. Diagram Showing Relation Between Ability to Stand Resetting, and Activity, Fineness and Proportion of Various Ingredients.

Fig. 9 shows that the less oxide of magnesium a cement contains the less it is affected.

Fig. 10 shows that the amount of alkalies has no affect upon the resetting properties.

As a result of the above experiments, tables, curves and conclusions, it is recommended that the process of retempering of cement mortar be prohibited by inspectors on all works where the strength of the cement is desired, and as it is always desired that the cement attain the maximum strength in its power, it should never be allowed to receive its initial set and then to be mixed again.

WORLD'S COLUMBIAN EXPOSITION.—I.

One of the great events of the year, and one which will be of particular interest to our readers in many ways, will be the World's Columbian Exposition, at Chicago, which is to be opened on May 1 and will continue until the end of October. During the past year we have devoted considerable space to the exposition, and the progress of its preliminary work, having published much statistical matter and general information respecting it, and having also illustrated and described the construction of the principal buildings, as well as other matters of engineering interest. We have, in fact, gone more completely into the description of the exposition than any other technical paper, and during the present year we shall continue to publish matter relating to the exposition, more especially in regard to the engineering features, and expect to give our readers very complete information as to the exhibits. It will be understood by what we have already published that the exposition will surpass any previous exposition in the completeness of its arrangements for sewerage and water supply, in its size, in the construction and architectural design of its buildings, and in artistic effect generally. It is practically certain, too, that it will surpass all others in the extent and completeness of its exhibits.

History of the Exposition.

Dr. T. W. Zaremba, a citizen of Mexico, is said to have been the first man to suggest a World's Fair in celebration of the 400th anniversary of Columbus's discovery of America. The idea came to him at the Centennial at Philadelphia, but it was not until Nov. 13, 1882, that he broached the subject to John C. Fremont, Peter Cooper and others in New York. On June 11, 1884, he sent to the diplomatic representatives of foreign powers at Washington an invitation to a conference to consider the subject of a fair in Mexico, and confided his plans to others at later dates. In the autumn of 1885 the suggestion was taken up by a Chicago newspaper, which asserted that that city was the best place in which to hold the fair. Dr. Zarema went to Chicago, and on Nov. 24, 1885, received from the Secretary of the State of Illinois a license to organize the Chicago Columbian Centenary World's Fair & Exposition Co. Nothing came of this, however, but in 1886 Dr. Zarema brought his plan to the attention of the American Historical Society, in session at Washington. That body appointed a committee to confer with the President with the hope that he would bring the scheme before Congress. Following this action, Philadelphia sent a committee to Washington to get an appropriation for a celebration in that city. In February, 1882, Dr. Harlan, of Chicago, sent a letter to a Chicago newspaper suggesting Chicago as the proper place for a Columbian exhibition. In 1885 this suggestion was revived, and a joint committee was appointed from the Commercial Union League and the Iroquois Club to take action to secure the fair. Early in 1886 a board of promotion was organized in New England to secure Congressional action, and July 31, 1886, Senator Hoar, of Massachusetts, introduced a resolution for the appointment of a joint Congressional Committee of 14 to consider the advisibility of holding a fair.

On July 22, 1889, the Chicago City Council adopted a resolution instructing the mayor to appoint a committee of 100 to induce Congress to locate the fair in that city. On Aug. 15, 1889, a state license was granted to De Witt C. Cregier and others to open subscription books for the proposed corporation. Dec. 19, 1889, Senator Cullom, of Illinois, introduced the first World's Fair Bill in the U. S. Senate. Jan. 11, 1890, the Senate Committee listened to the delegations from New York, Chicago and other cities in support of their demands for the location of the fair in their respective cities. Feb. 24, 1890, Congress voted to have the fair in Chicago, and by March 23 the necessary $5,000,000 capital had been subscribed. On April 4 the subscribers elected a Board of Directors, which elected Lyman J. Gage as President. April 25 President Harrison signed the bill locating the fair in Chicago.

Then on June 12 a special session of the Illinois State Legislature authorized the city of Chicago to increase its bonded indebtedness $5,000,000 in aid of the exposition, and the name was changed to the World's Columbian Exposition, with its capital increased to $10,000,000. June 26 the commissioners appointed by the governors of states under the act passed by Congress April 25 creating a national commission, held a meeting in Chicago and organized. July 2 Jackson Park was selected as the site for the fair. Sept. 19 George R. Davis was elected Director-General, and Nov. 20 the Board of Lady Managers, also provided for under the act of Congress of April 25, held its first meeting. Dec. 21 the President issued his proclamation inviting foreign nations to participate. April 4, 1891, the first annual meeting of the stockholders was held and a new Board of Directors elected. July 2 the ground was broken for the first buiding, that of Mines and Mining. April, 1892, the second annual meeting of the stockholders was held. Aug. 12, 1892, a Council of Administration was elected and invested with all the powers of the two governing bodies in all matters except appropriations of money. Jan. 18, 1892, Chicago was visited by a Congressional committee, which inspected the work already done. Its report was made the basis for the additional appropriation by Congress of $2,500,000 in half-dollars. In October, 1892, there were issued $4,000,000 in 6% bonds.

Finances.

The city of Chicago gave for the exposition a fund of $10,000,000 and a park of nearly 700 acres, and it is estimated the exposition will prove a valuable investment for the men who subscribed to its stock and bonds. In round figures the city of Chicago and its citizens have subscribed $10,500,000. An appropriation from the United States Government has been made of $2,500,000 in souvenir coins of the denomination of 50 ct. pieces. The exposition managers propose to sell these for $1 each, and many have already been taken at that price, while large premiums have been paid for some of the coins. This will make the government appropriation equal to $5,000,000. The exposition has also issued bonds to the amount of $4,000,000, payable in two years, bearing 6% interest. This makes the total amount of money available up to the time of the opening of the gates $19,500,000. It is estimated that the gate receipts will foot up at least $10,000,000; that $3,500,000 will be received from concessions and privileges, and that the salvage will amount to $1,500,000. The total estimated receipts thus amount to $34,500,000 The disbursements are estimated as follows: Cost of constructing the buildings and preparatory expenses up to May 1, 1893, $18,750,000; operating expenses from May 1, $2,500,000; total disbursements, $21,250,000, leaving the net amount available for paying the indebtedness, $13,250,000. This indebtedness consists of the two issues of bonds, one made by the city of Chicago, amounting to $5,000,000, and the one made by the exposition of $4,000,000, and the stock subscriptions amounting to $5,500,000. The payment of the bonds will leave $4,250,000 for the stockholders, who will thus receive back 85% of their subscriptions. Most of these subscriptions were made without expectation of direct financial returns, it being thought that the city would profit generally by the numbers attending the fair, so that business men could afford to subscribe liberally. With 85% of their original subscriptions returned, however, these men can congratulate themselves on having been farsighted enough to have had confidence in the success of the fair. There are a large number of small subscribers from the working classes, the total number of all the contributors being over 30,000.

World's Congress Auxiliary.

This department has been organized to provide for the presentation, by papers, addresses and discussion, of various matters of social and technical interest. There have been congresses held simultaneously with or under the management of other expositions, notably at Paris in 1889, but no such elaborate programme has been arranged before. The work is under the direction of C. C. Bonney, who first broached the idea to the management of the exposition. The organization was carried out and officers were elected for the conduct of the work. These officers have never been changed, thus securing permanency of effort. The work as it developed was arranged in 16 great departments and subdivided into 106 general divisions, which are again subdivided into chapters and sections whenever the nature of the work demands. The original announcement of the Auxiliary was made a state paper by the U. S. Government, and transmitted by the State Department with the President's proclamation and invitation to all foreign nations. This recognition of the Auxiliary by the Government was confirmed by an act of the last Congress granting an appropriation for expenses. The foreign ministers of the United States have been made honorary members of the Auxiliary and act as its agents in communicating with foreign governments. It is estimated that from 10,000 to 40,000 persons will be in attendance at some of the congresses. To accommodate the anticipated attendance arrangements have been made to hold the congresses in the permanent Art Palace, now in progress of erection in the Lake Front Park, at the foot of Adams St., in the very heart of the city. The World's Fair Directory contributed $200,000, to be united with $400,000 received from the sale of the building formerly occupied by the Art Institute, to cover the cost of this Memorial Art Palace, which was designed by Shepley, Rutan & Coolidge, of Boston. There will be two large audience rooms in the Art Palace, which will accommodate 3,500 persons each. In addition, there will be 30 rooms, two of which will seat 1,500 each, and the others from 300 to 700 each, thus enabling a very large congress to hold meetings of many sections at the same time. The Auditorium will also be used for meetings if necessary, and a large temporary structure similar to the Chautauqua Amphitheatre may be erected if it is found that the attendance is likely to be too large for the places of meeting already arranged for.

The leading idea of the congresses is the arrangement of all the departments of human progress in a consecutive and harmonious order, and the second characteristic is that all congresses are to be conducted on a dual plan. In every department there is to be first a so-called popular congress intended to excite popular interest, in which are to be presented graphic and comprehensive summaries of human progress down to the year 1893; and second, in alternate sessions during the same general period special congresses will be held in which will be presented the living questions of the day in the different departments. Both the subjects to be considered and the persons to present them have been selected with the greatest care by the committee and advisory councils. The longest practicable time has been given for the preparation of papers. The aim in every congress will be to present the more mature thought of the world in a form suitable for publication. There will be no time for rambling discussion nor haphazard debate. It is proposed to introduce at the sessions of each congress the largest number possible of distinguished persons as participants in the discussions or as presiding officers. The congresses are planned to begin in May and extend in a continuous series to the last of October. The average time for each department will be nearly two weeks, but some congresses will need more or less time than this. The religious congresses have applied for four weeks. The principal departments are: Religion, Labor, Temperance, Commerce and Finance, Education, Engineering, Art, Government, Science and Philosophy, Literature, Moral and Social Reform, Medicine, and the Press. We have commented upon some features of these comprehensive congresses in our issues of Oct. 6 and 27.

Foreign Countries.

The following countries have officially made application for space to Mr. Walter Fearn, Chief of the Department of Foreign Affairs in addition to those mentioned in the table below and have received allotments: Bulgaria, Chile, China, Corea, Hungary, Italy, Madagascar, Persia, Servia, Siam, Switzerland, and Venezuela, and all the British colonies and possessions. The following countries will have independent government buildings: Austria, Canada, Ceylon, China, Colombia, Costi Rica, Ecuador, France, Great Britain, Guatemala, Haiti, Italy, Japan, Nicaragua, Norway, Russia, Sweden, and Turkey. Concessions for conducting theatres, restaurants, shops, and representations of native life have been granted for the following countries: Algeria, Austria, China, British India, Dahomey, Egypt, Hun-

gary, the islands of the Pacific, Italy, Japan, Morocco, Persia, Sandwich Islands, and Tunis.

The following table shows the appropriations made by various foreign governments up to this time:

Argentine Rep...	$100,000	Greece.	60,000
Austria.....	102,300	Guatemala.	200,000
Belgium.....	57,000	Hawaii.	40,000
Bolivia.....	30,000	Honduras.	20,000
Brasil.....	600,000	Haiti.	25,000
Colombia.	100,000	Japan.	630,000
Costa Rica.	150,000	Liberia.	7,000
Denmark.	67,000	Mexico.	50,000
Danish West Indies.	1,200	Morocco.	150,000
Ecuador.	125,000	Netherlands.	100,000
France.	733,400	Dutch Guiana....	10,000
Germany.	800,000	Dutch West Indies.....	5,000
Great Britain...	291,000	Nicaragua.	31,000
Barbados.	5,840	Norway.	50,280
British Guiana....	25,000	Orange Free State.	7,500
Brit. Honduras..	7,500	Paraguay.	100,000
Canada.	100,000	Peru.	140,000
Cape Colony.....	50,000	Russia.	46,320
Ceylon.	65,600	Salvador.	12,500
India.	30,000	San Domingo. . ..	25,000
Jamaica.	24,333	Spain.	14,000
Leeward Islds...	6,000	Cuba.	25,000
New So. Wales...	243,325	Sweden.	108,000
New Zealand.....	27,000	Uruguay.	24,000
Trinidad.	15,000		

Total (approximate).....$5,750,000

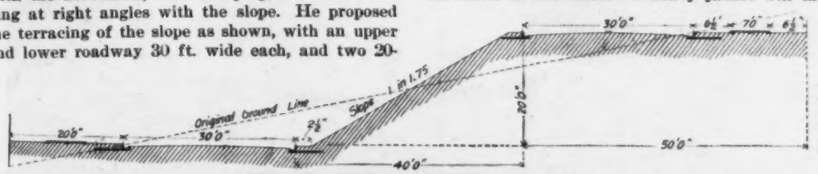
It is estimated that the expenditures of foreign governments, in addition to the above, will be at least $2,500,000. The following table shows the estimated assignment of space already made to some of the prominent nations:

	Sq. ft.		Sq. ft.
Austria.	150,000	British Colonies...	100,000
Belgium.	120,000	Canada.	70,000
Denmark.	20,000	Greece.	10,000
France.	250,000	Russia.	100,000
Germany.	250,000	Sweden.	40,000
Great Britain....	250,000	Norway.	50,000
Japan.	60,000	Italy.	45,000
Mexico.	61,000	Spain.	30,000
Total.			1,600,000

It is stated that the space already allotted to foreign nations alone exceeds the total space of any previous World's Fair. In addition to this will come the space of American exhibitors, which far exceeds the aggregate of all the foreign nations of the world. Nearly every state in the Union has made appropriations for state buildings and state exhibits, and there are already under construction no less than 30 state buildings.

SIDE-HILL STREET GRADING IN TACOMA.

The cross-section here shown was proposed by the City Engineer, of Tacoma, Wash., Mr. J. M. Morrison, to overcome a side-hill grading difficulty. The original surface lay at an angle of about 12° with the horizontal, with the proposed street running at right angles with the slope. He proposed the terracing of the slope as shown, with an upper and lower roadway 30 ft. wide each, and two 20-ft. footways, with a 7-ft. board walk in the center of each.

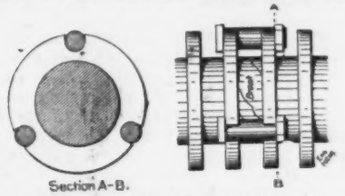


SIDE HILL STREET GRADING IN TACOMA.

The difficulty with the plan here illustrated was that Union Ave. ran directly across the main lines of travel, and any one passing between the town and the county was compelled to go to one end or the other of the avenue before passing on their way. The blocks are only 280 ft. long in this section of the city, and the plan finally adopted was as follows: Commencing with a wide, sloping sidewalk at the upper property line there was a terraced bank 8 ft. high dropping down to a 60-ft. street; following this was another 8-ft. terrace with a wide sidewalk at the foot. This plan had the merit of allowing all cross streets to be cut through, but on a pretty steep gradient. Tacoma has graded 32 miles of streets this year, and has otherwise pushed her public works in a manner typical of that section of our country. The plan from which our cut is made indicates, however that wood enters largely into this new construction. The 20-ft. footways have a 7-ft. board walk in the center made of 2-in. plank resting on three 3 × 6-in. stringers. And the gutters are made of 2-in. and 3-in. plank, with a 2 × 6-in. tie, 6 ft. long, running under the bank.

REPAIRING THE BROKEN SHAFT OF THE UMBRIA.

The news that the Cunard steamer "Umbria" was drifting in mid-ocean during a raging winter storm while the engineer made repairs on a broken shaft brought great relief to those who had friends on board the delayed vessel, but aroused a vast deal of curiosity among engineers everywhere as to how a broken screw shaft on a modern Atlantic greyhound could be mended with the tools and material available on board the ship. Probably some 15,000 HP. is transmitted from the "Umbria's" engines to her propeller by means of the shaft. To repair a break in this great cylinder, which is some 26 ins. in diameter, in such a manner as to enable it to transmit a small part even of the engine's power



Repair of Shaft of S. S. "Umbria."

would appear to be practically impossible. A torsional strain which snaps a section of solid metal nearly 4 sq. ft. in area is not to be controlled by any weak makeshift.

The solution of the puzzle was not known until the "Umbria" herself arrived in port. It appeared that the fracture took place in the thrust bearing between two of the flanges. The irregular running attracted the attention of the engineer, who stopped the engines, took off the thrust bearing cap and found that a break had occurred extending about three-fourths through the shaft. The accompanying sketches show how the break was repaired. The opposite flanges, between which the break occurred, were cut into and grooves were made in which heavy bolts were placed and held by straps passing around the shaft. Published accounts give the diameter of the bolts as 6 ins. By this expedient a coupling was made of sufficient strength to transmit the power from the engines to the screw when running at a 6 to 10 knot speed.

Repairs on the same principle are to be made to permit the vessel to recross the Atlantic. The number of bolts joining the flanges will be increased to 10, and bolts will also be put through the crack in the shaft. A heavy jacket will then be put on surrounding the coupling bolts, and the vessel will make the journey at slow speed to the other side, where the broken section of the shaft will be replaced.

THE LAWRENCE EXPERIMENTS ON THE PURIFICATION OF WATER IN 1890 AND 1891.

In our issue of Dec. 15, 1892, the experiments on the purification of sewage made in 1890 and 1891 by the Massachusetts State Board of Health were reviewed. Very interesting experiments on the purification of water by downward filtration through sand were carried on at Lawrence during the same period, and also as outlined in our issue of July 11, 1891, during the two previous years. While in sewage purification the chief object is generally to remove organic matter capable of putrefaction in the filtration of sewage polluted water the removal of disease germs is most important.

Chemically considered, the water from the Lawrence filtering tanks during the years 1890 and 1891 has been well purified, and the color removed or reduced according to the rate of filtration. In addition, with proper filtering material and manipulation, a very large percentage of the bacteria naturally found in Merrimack River water have been removed.

The following table shows the character of the filtering materials used in the several tanks, and following the table is some comment on the same.

Filter. No.	Depth material, ft.	Size of sand grains, mm.: 1% finer than	Thickness of loam layers, ins.	Size of grain of loam, mm.: 10% finer than	Kind of filtration.	Method of filling tans.
8	5	.35	8	.04	Intermittent.	Wet.
18A	5¼	.48	0	—	"	"
20	5¼	.48	0	—	"	"
20A	5	.48	12	.06	"	"
33*	5	.26	2	.05	"	"
34*	5	.26	2	.05	Continuous.	"
35*	5	.26	2	.05	Intermittent.	"
36*	5	.26	2	.05	Continuous.	"
33A	5	.12	0	—	"	Dry.
34A	5	.07	0	—	"	"
35A	5	.19	1	.07	Intermittent.	"
36A	5	.19	1	.07	Continuous.	"
37	5	.19	0	—	"	"
38	2	.19	0	—	"	"
39	1	.19	0	—	"	"
40	1	.19	1	.07	"	"
41	5	.12	3	.07	Intermittent.	"

* Not now in use.

These filters were so arranged as to give a direct comparison of the effects of sands of different degrees of coarseness, of different depths of the same sand, of different rates of filtration, of the presence of loam layers, and of continuous and intermittent filtration.

The number of bacteria in the applied water and in the various effluents have been determined each day, the numbers so obtained, giving an idea of the efficiency of the different filters. Results of the determination of species have shown, however, that the numbers observed in the effluents are great than the numbers actually passing the filters. It was found, for example, in Filter No. 8, in November and December, 1891, that the most abundant form in the applied water was totally absent from the effluent; and that the species found in the effluent were very vigorous forms, capable of growing on an extremely small food supply, and that they probably grew in the underdrains and did not come from the applied water.

The relative positions of loam layers is not stated for all the filters, but in No. 8 the top of the loam was 6 ins., and in Nos. 33, 34, 35, and 36, 12 ins. below the surface.

The following table gives the results secured by filtering water into which pure cultures of typhoid and other more easily recognizable bacteria had been introduced:

Filter.	Date.	Gallons of water applied, daily rate per acre.	Species of bacteria applied.	Per cent. of bacteria removed.
No. 8.	1891.	183,000*	canal water	100
18A	Daily counts, Dec. 7, 1891, to March 19, 1892.....	963,000	canal water	99.51
	March 2.....	980,000	typhoid	99.95
	11.....	1,000,000	typhoid	99.
	23.....	860,000	typhoid	99.9
	28.....	780,000	prodigiosus	99.4
35	Feb. 24.....	340,000*	typhoid	100.
	March 2.....	320,000*	typhoid	100
	10.....	280,000*	typhoid	100
36	Feb. 24.....	460,000*	typhoid	100
	March 2.....	400,000*	typhoid	100
	10.....	400,000*	typhoid	100
33A	May 2.....	2,020,000	prodigiosus	100
	5.....	1,780,000	coli communis	100
34A	May 2.....	2,020,000	prodigiosus	100
	5.....	1,900,000	coli communis	100
35A	April 1.....	860,000	prodigiosus	100
	12.....	1,580,000	typhoid	100
	15.....	2,140,000	typhoid	100
	26.....	2,740,000	typhoid	98.4
	28.....	2,000,000	coli communis	87.3
	May 11.....	2,380,000	coli communis	98.6
	19.....	1,740,000	prodigiosus	100
	25.....	1,540,000	typhoid	99.84
36A	March 31.....	980,000	prodigiosus	100
	April 11.....	1,540,000	typhoid	100
	26.....	2,100,000	typhoid	97.22
	28.....	1,940,000	coli communis	98.45
	May 18.....	2,000,000	coli communis	99.75
	19.....	1,940,000	prodigiosus	100
	25.....	1,540,000	typhoid	99.86
37	April 26.....	900,000	prodigiosus	100
	27.....	800,000	prodigiosus	100
	May 2.....	1,480,000	prodigiosus	100
	5.....	1,600,000	coli communis	99.99
	11.....	1,400,000	coli communis	100
	19.....	1,540,000	prodigiosus	100
	25.....	1,540,000	typhoid	100
38	May 3.....	1,020,000	prodigiosus	100
	5.....	960,000	coli communis	100
	11.....	940,000	coli communis	99.85
	19.....	1,540,000	prodigiosus	100
	25.....	1,500,000	typhoid	99.16
39	May 3.....	1,060,000	prodigiosus	100
	5.....	1,000,000	coli communis	99.88
	11.....	960,000	coli communis	99.35
	19.....	1,580,000	prodigiosus	99.60
	25.....	1,540,000	typhoid	99
40	May 3.....	980,000	prodigiosus	100
	5.....	1,020,000	coli communis	99.99
	11.....	960,000	coli communis	99.86
	19.....	2,120,000	prodigiosus	99.73
	25.....	1,480,000	typhoid	98.44
41	June 20 to 26....	1,786,000	canal water	99.75

* The maximum quantity of water which could be made to pass the filter.

In all 14 different filters were used in these experiments. Typhoid bacilli were applied to 10 of the filters, and of 20 different applications all of the typhoid bacilli were removed from 10, 99% or over from seven, over 98% from two and 97.22% from the remaining filter.

Further comments on these special experiments and the general subject of water filtration can best be given in the words of Mr. Allen Hazen, as follows:

In some of the earlier experiments the quantity of food material applied with the bacterial dose was so great as to support a vigorous growth of bacteria in the lower part of the filter and in the underdrains, greatly increasing the numbers observed in the effluents in those cases, when the removal was not complete. In many cases the doses applied contained a vastly greater number of bacteria than could ever exist in a practical case, sometimes exceeding a million per cubic centimeter in the applied water. With these excessive doses, a much larger percentage of the bacteria are able to pass; and from the later experiments, where these conditions were avoided, we may safely conclude that in actual practice, with smaller numbers of bacteria constantly added with the applied water, nothing like the percentages given in a few of the above experiments would be able to pass the filter.

The general result of these exeperiments, as far as completed, is to show that, with the same material and rate, the deeper filters are much safer than the more shallow ones; that low rates are safer than high rates, and that, at the same average rates, continuous is quite as effective as intermittent filtration in the removal of bacteria. The formation of a surface film or covering, regarded by Piefke* as of prime importance, appears, thus far, to have had very little influence on the results. Further discussion of these and other points is postponed until more complete data are obtained.

The results already obtained clearly show that, with due care in the selection of the filtering material, filters can be constructed and operated at rates up to one and one-half to two million gallons per acre daily, with the removal of substantially all of the bacteria. These results, taken in connection with the remarkably low death rates from diseases known to be capable of conveyance by drinking water in some European cities having filtered water supplies, from polluted sources, leave no room for doubt as to the efficiency of suitable filtration as a safe-guard against water-carried diseases.

The experiments with typhoid bacilli have especial value owing to the fact that, according to the report, when the work was begun "there was no reliable method for its differentiation from several species regularly present in the water of the Merrimack River at Lawrence," of which five present the same characteristics under some circumstances, As a result of several months study, Mr. Geo. W. Fuller states that the typhoid bacillus can now be differentiated "beyond all reasonable doubt from every species of bacteria hitherto met with in the Lawrence waters." The results of Mr. Fuller's investigations are given by him in a special paper in the report of the Massachusetts State Board of Health for 1891, to which those interested in biological work are referred for details. Regarding the results of the work at Lawrence Mr. Fuller states:

From this evidence it is fair to conclude that with the filtering materials here used, all of the bacteria of the Merrimack River may be removed by intermittent filtration. This important result has not been reached hitherto.

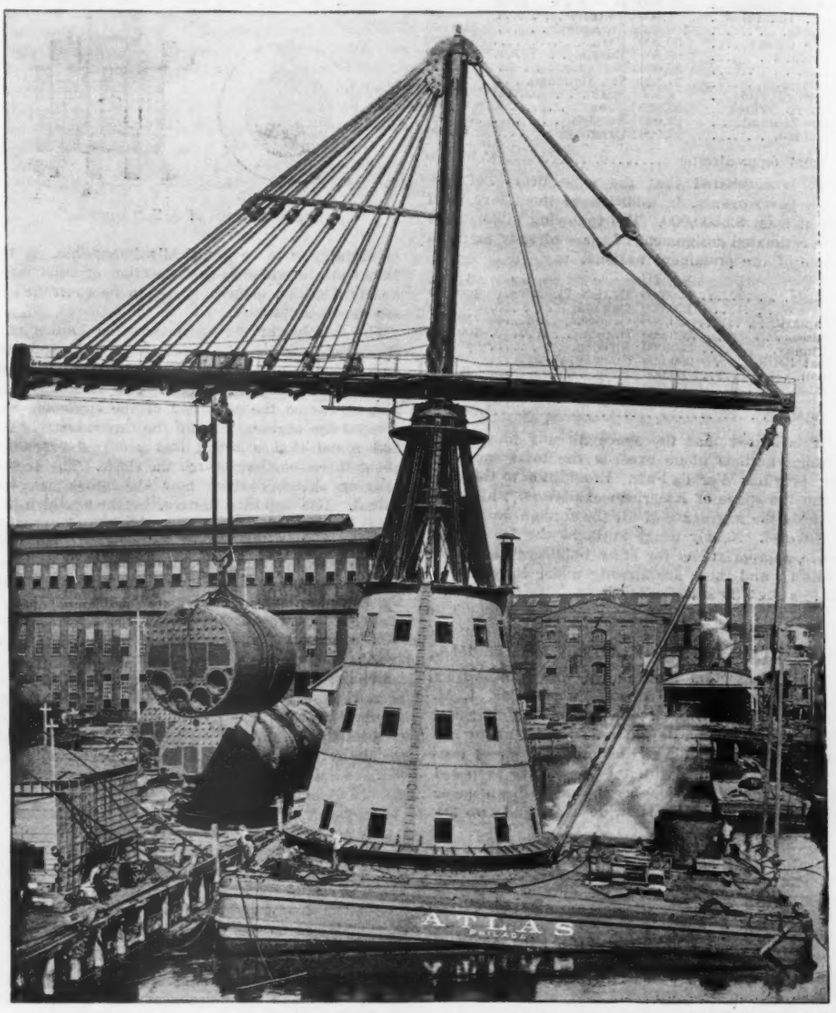
The work at the Lawrence Experiment Station is conducted with Mr. Allen Hazen, Chemist, and Mr. Geo. W. Fuller, Biologist, in charge. Mr. Harry W. Clark is Assistant Chemist. Profs. T. M. Drown and W. T. Sedgwick, of the Massachusetts Institute of Technology, are respectively Consulting Chemist and Biologist, with general oversight of the investigations made.

A FLOATING 125-TON DERRICK.

In our issue of Dec. 8 we referred to a floating 125-ton derrick lately designed, built and owned by the William Cramp & Sons Ship & Engine Building Co., of Philadelphia, Pa. By the courtesy of Messrs. Cramp we are enabled to present a view of this derrick as it appeared when lifting a 70-ton boiler from the dock.

To repeat to some extent our previous description, this derrick has a perpendicular lift of 60 ft. and an overhang of boom of 35 ft. The mast is 116 ft. high, 3 ft. in diameter, and is made of steel, inside braced. The supporting cone is also built of steel plates and is 65 ft. high. This cone revolves on 42 4-in. steel balls, with another set of ball-bearings at the head of the cone, 51 ft. below the head of the mast. The steel lifting arm is 65 ft. long, measured from the center of the mast; the counter-balance arm is 50 ft. long, and is stayed to the bottom of the cone by steel cables and to the hull of the pontoon by steel eye-bars. The hoisting gear connected with the traveler on the lifting arm is fitted with 1½-in. wire rope and 30-in. pulleys.

The iron pontoon supporting this derrick is 69 ft. long, 62 ft. wide, and is 13 ft deep. Watertight compartments, which are filled from the river and emptied as required, assist in counterbalancing the load. The boiler shown in the cut was lifted from the dock, the derrick towed itself 100 ft., and the boiler was lowered into the hull of the warship "New York" by two men in 25 minutes.



125-TON FLOATING DERRICK, BUILT BY THE WILLIAM CRAMP & SONS SHIP AND ENGINE BUILDING CO.

MILITARY RAILWAY CORPS IN EUROPE.

The establishment of a railway corps as part of European armies is discussed in a book recently published by Ulrich Meyer, of the German Railway Corps, and some very interesting particulars are given of the organization and work of this branch of military service.

In 1842, when Points wrote a book in which he pointed out the important part in warfare which could be played by railways, even military men considered his views and predictions exaggerated, but in the war of 1859 their correctness was proved. In the Civil war in the United States in 1861-64, the northern states saw at once the importance of the railways, and appointed Gen. MacCallum military chief of all the lines of the Union. This officer not only organized a military system of traffic, but he also formed the first military railway field corps. Prussia, with its army administration always on the alert, was the first European state to follow the example, and just before the breaking out of the war of 1866, the first organizaion commenced its operations, but in 1869 a new and more complete plan was elaborated. Under the Franco-German war the old organization had to do duty, but after the war a complete military railway service was organized. Since 1890 Germany has acquired a railway brigade consisting of two regiments of four batallions, including a Wurtemburg and a Saxon corps, in addition to the railway batallion of Bavaria, composed of two companies. Thus, the German empire possesses 18 military railway corps, each consisting in time of peace of five officers and 122 men, and in time of war of eleven officers and 233 men. In the field each company is to constitute a tactical division.

As already stated, Germany had until after the Franco-German war, a railway organization half military, half civil, but nevertheless it worked well. The special duty of the military railway corps is to repair lines destroyed by the enemy, and therefore the first German divisions were composed of ordinary railway servants and laborers, with pioneers and officers of engineering. The men selected for the railway brigade are only recruits of intelligence and good education, and those who have a technical training, such as railway employees, builders, mechanics, smiths, enginemen, carpenters, miners, etc. They generally join in the autumn, and having passed through the school for recruits until the following spring, commence their duty in the railway service. They have for their training a special railway line of about 50 miles in length, running from Berlin to the artillery grounds at Zossen. This single line also carries in certain parts passengers, but the entire staff is in military uniform. The doorkeeper is in the uniform of a sergeant, the ticket clerk and station master are in uniform, and the ticket collector (as is the custom in Germany), is a soldier with a

* Zeitschrift fur Hygiene, 1889, vol. ii., p. 115.

helmet and carrying a sword. The conductor is a sergeant in uniform. He reports in military style to the station master the departure of the train prior to giving the signal. All switchmen, porters and baggagemen are soldiers, and the trackmen at work along the line are in uniform, and have their guns stacked by the side of the track, while at each crossing, etc., stands a soldier in full uniform with his rifle.

The troops ordered for guarding the line have always seen much service and remain a month at their post before being relieved. Generally they are quarterd in the nearest village for the night, as on this line there are no night trains. Nevertheless the duty, particularly in the winter, is very trying. Naturally this line is of great service, as here the men become practically instructed in the transport of ordnance, ammunition, troops, horses, etc., and the railway troops are never idle, as when not engaged on the line they receive technical instruction or are engaged in drill.

In the second year of service some of the men are ordered to the balloon corps attached to the railway service. The rest are exercised in telegraphy, the construction and destruction of telegraph lines, bridges, tunnels, railway tracks, and stations. These exercises are, of course, made as practical as possible. To these tasks is added the construction of railways, often lasting months, in any part of the country where such are being built, whether state or private lines. The private railway companies during such time pay the soldiers wages, diet money to the officers, and lose nothing thereby. The men are also ordered to the fortifications to construct narrow-gage lines in the trenches or between the forts.

It will therefore be seen that the German railway troops receive a varied training; but although the service is severe enough, many volunteer for the same even among the so-called "one yearly." For the training received in the railway corps is a great recommendation when afterward seeking employment in the service of private companies; and with the enormous competition this fact carries great weight.

The German War Office, when war breaks out, has, if the reserves be included, at its disposal several thousands of able railway men, while in addition certain officers, non-commissioned officers and men, are ordered to do extra duty in certain branches of the railway service. They do not, however, partake in the destruction and repairing of the railways, but assist in managing the traffic, etc. Finally, the German cavalry is specially trained in the laying of telephones and telegraphs, and their destruction. It may seem an easy matter to "cut the wires," but it is not so, as the enemy must not at a glance learn where the destruction has taken place, or it would be at once repaired. Therefore, the cavalrymen deputed for this service are furnished with an ingenious "step-iron," which is fastened around the knees, and which enables them to climb telegraph posts, like American telegraph linemen. Then the wires are wound with fine silver thread, which causes a deflection of the current, and renders the line useless. But this fault is difficult to find, and, therefore, equally difficult to repair.

The United States, where railway corps were first formed, no longer possess any. Nor have the armies of Sweden, Norway, Denmark and Turkey any special military railway service.

In France a railway corps was established in 1870, but it was captured at Metz. In 1875 the organization of railway sappers was commenced, and the French army now possesses railway companies of such, each consisting in time of war of nine officers and 228 men. In addition, there are in time of peace five railway field divisions, each composed of 1,273 men who are civil railway servants of the state lines. Thus France has adopted the mixed system.

In Russia, a railway corps of 1,000 men was formed in 1869. The men were taken from all branches of the service, and had to serve twelve years. In 1872 their depot was transferred to St. Petersburg, and the corps built the line to the permanent camp at Zarskoje-Selo, six miles in length. During the Turkish war two railway battalions were formed, which managed the entire service, but which did not construct railways, this being left to private contractors. At present the military railway service of Russia consists of 6 batallions of 5 companies, or 30 companies in all.

Austria-Hungary, too, established in 1869 railway corps, which were trained on various lines, and when in 1878 Bosnia was occupied, the existing five divisions were increased by four more, and these put into working order the Banjaluka-Doberlin railway, 65 miles in length. This line is still worked as a military line, and is subventioned by the Austrian War Office. The latter has now in time of peace 12 companies, each composed of 5 officers and 111 men; but in war the number is doubled, and a division of railway laborers attached to each.

Italy had no special railway corps until two years ago, when a brigade was formed, consisting of 4 companies, each of 4 officers and 100 men. But in war, 8 companies of 5 officers and 270 men are furnished. In order to train these men, the Italian War Office has made arrangements with the Turin-Torre-Pellice Ry., owned by a private company, by which all management of the same with its branch lines, except financially, is carried on by them. The railway company by this arrangement pays only four-fifths of the usual costs, and the state loses nothing thereby, as the money received is expended in the maintenance of the railway brigade.

England is said to have done less than any other country in this respect. A railway corps does exist, but it is of very little consequence. Belgium has but one railway company, in which officers and men of all arms receive training, and Holland has only one company of 6 officers and 94 men, but in case of war conscript railway men are called for service. Bulgaria and Portugal have each a railway company, and Roumania one among its four batallions of engineers.

THE ENGINEER AND HIS WORK.*

By Benj. F. Isherwood, ex-Engineer-in-Chief U. S. Navy.

The present is one of the very few occasions on which there has been an assemblage exclusively of engineers for purely social intercourse, and the hope is to be cherished that hereafter these gatherings will be much more frequent, and with results greatly to the benefit personally of those concerned, and of the profession of engineering at large. Only on such occasions can the real sentiment of that profession take such form and pressure as will enable it to become a working factor in the advancement of engineers in a commercial sense. The assemblages under the name of "institutions," which at periodic times take place among engineers, are, and have been, wholly of a professional nature, and the results have been, and were intended to be, entirely technical. The dissemination of engineering information, the announcement of engineering discovery, and the improvement of theories and inferences due to intelligent criticism given from many points of view according to individual experience, character and peculiarity of intellect, are of the highest importance, but mainly to the world, and only in a comparatively insignificant degree to the individual engineer. The world reaps the harvest of such skillful cultivation, but the husbandman receives only his daily wage, which is but little influenced by the value of his products. And this will continue so long as engineers work solitarily, separate from their fellows, ignorant of their conditions and sentiments, and without concert of measures for protecting and advancing their secular interests. To accomplish the latter, engineers must meet as we meet to-night, not for technical purposes, but to socially discuss the ways and means best adapted to produce success, bringing their combined knowledge, talent, energy and force of character to the work.

Of all the various professions, the most important is engineering, applying the term in its broadest sense. It is the only productive profession, by which is meant that it is the only profession which can make two blades of grass to grow where but one could be made to grow before. It is the only profession which contributes directly to the comforts and conveniences of life, and, indirectly, to the highest development of man; for until his physical well-being is assured, man can make but little moral or intellectual advancement. In comparison of what the engineer has done for his race, the achievements of poets, artists, priests, lawyers, soldiers, doctors, writers and statesmen seem insignificant. On the one side are the great tangible realities of life: The invention and perfectionment of the vast and complex machinery of manufactures in all their wonderful variety and for all their valuable purposes; the creation of labor-saving machines, the steam engine being incomparably the greatest, whereby the labor of a man is increased a thousandfold; the designing and construction of the means of transportation by sea and land, the railroad and the steamship; the communications by telegraph and telephone; and, in brief, the entire creations of practical mechanics. Strike the works of the engineer from the earth, and what would be left? Why, really only works of imagination, under which term all other achievements may be philosophically grouped. This is all that the other side has to offer: Fiction and the violence which is the result of ignorance, against fact and the beneficent application of the immutable laws of the universe; beggary, savagery, cold and hunger with the crimes, vices and errors they engender, against personal safety, abundance and comforts with the virtues and the intellectual and moral development which attend, and seem to be inseparable from, the physical well-being of man—in a single phase, the man of the dark ages against the man of to-day; for the whole difference between the two is the direct product of the labors of modern engineering.

Of all engineering specialties, the most important is "steam engineering," because it is the sine qua non, as without it most of the others could not exist. It is the foundation, being the creator of physical power, while the other specialties only follow as based upon that power, using it and modifying its application in continually increasing directions, and for continually increasing purposes.

There can be no question that engineering is the most important profession existing, for modern civilization has been created by it and can only progress as it progresses; but the world seems to have forgotten its greatest benefactor, and to have turned its admiration and rewards on what are merely consequential and not causal; on the flies resting upon the swiftly revolving wheels that carry forward the car of time, and not on these wheels themselves.

Although engineering is the most important profession, engineers being the great captains of industry, it is the worst rewarded of all the professions, and its most expert practitioners are far from receiving the recognition either in fortune or prestige which their services deserve. Though they have created the rich man's table, they are begrudged the crumbs that fall from it. They remain unnoticed while rank and consideration are showered upon mere figureheads who appropriate what they have not earned and occupy places they cannot fill. This error of society is a consequence of its ignorance; it is mole-eyed and unthinking, meaning to be just, but unable to properly discriminate; it bestows where there is no desert, and withholds without intelligence. It blindly gropes its way, making many mistakes, and only convinced by the long and expensive tutorship of experience. There must be a campaign of education, and many of them, perhaps, for the proportion of leaven is very small to the immense mass of dough. Patience, perseverance and ability will do much in the future, as they have done in the past. The inexorable logic of events will convince those who cannot be otherwise convinced; privilege, inefficiency and false pretense cannot last forever, even among the most stupid, and the world will, after a time, discover what its true interest is, and that discovery once made, the future of the personnel of engineering is assured.

The misfortune heretofore has been want of association among engineers, and of that politic combination which furnishes the shortest and surest road to success. Each has lived too much alone, absorbed in the study of his profession or immersed in its practice without taking counsel of his fellows; and this has been the distinguishing characteristic of engineers of all times; it furnishes the true explanation of the small consideration they have received in popular estimation compared with the magnitude of the services they have rendered and the intellectual powers they have manifested. They have lived too exclusively in the world of thought, instead of in the world of man, and their struggles have been with the forces of nature rather than with the forces of society. All other professions than engineering are organized. Army, navy, law, church; trades of every kind and description, merchants and laborers, all are organized except engineering.

The first movements toward a proper organization are meetings, such as the present one, where interchanges of views and expressions of opinions can be freely had; where concerted plans can be devised, and processes of action adopted. And, above all, where a personal acquaintance inspires confidence in each other, as character and abilities become reciprocally known.

In the modern world intellectual power is the dominant factor. Public opinion accepts, and follows it as good, even when its works are evil. There is an irresistible charm in it, which makes foes friends in spite of themselves; but the public

* Remarks at the banquet of Naval Engineers at Delmonico's, Dec. 13, 1892.

often mistakes the light for the lamp, and bestows its admirations and rewards in the wrong place. Its perceptions must be better trained and directed; it sees the vast social transformation taking place, and for the better, but it cannot discern the underlying causes. Its attention must be drawn to the real power which has worked these wonders, and engineers must devote to this task some of the time heretofore consecrated to abstract science and to its practical applications. The gift, henceforth, must bear the name of the donor.

Germane to the subject, and among the amazing facts of the time, is the neglect with which the engineer officers of the navy have been treated by a popular government, which has selected one body of naval officers as the recipient of all its favors, while ignoring the services, merits and claims of its naval engineers, although the navy is really nothing but engineering, for without its engineers its vessels could not even move, and would be as idle as painted ships upon a painted ocean. This is the more inexplicable, as popular government, that is, democracy in the etymological, and not in the partisan, meaning of the word is the direct gift of modern engineering, which, by cheapening the ways and increasing the rapidity of transportation—that is, by facilitating inter-communication, has enabled this system of government, the most beneficent known to man, to be applied to a united continent, instead of being limited to isolated cities.

This want of appreciation, purely the result of inattention to the subject, of assurance and misrepresentation, of credulity in the wrong place, cannot last, and the reaction will come from sentiment crystallized by assemblies of engineers like the present. Then may be hailed the dawn of a brighter day when sense will supercede folly; and the true interests of a nation, instead of the antiquated privileges of a few, will determine the distribution of prestige and reward, and the relative importance of those who serve it. The truth only requires to be known. Let the efforts of all engineers be directed to that end, and let their guidance be these words:

Our Cause Against the World.

Micanite is the name of a new insulating material described in a recent paper before the Institute of Electrical Engineers. It is well known that mica is one of the best of commercial insulating materials, but it is so difficult and expensive to work that its use has been quite limited. It has been attempted to increase the range of use of mica by grinding it to powder and mixing it with a cementing substance. The paste thus formed can be easily molded to any desired shape, but the cement filling between the mica particles forms a conductor, and greatly lessens the insulating qualities. In the manufacture of micanite the mica is not ground, but is split into exceedingly thin flakes which are built up to the required thickness. A thin adhesive cement is used, and the surplus is squeezed out under pressure. The successive plates break joints, so that a current has to pursue a zig-zag course to follow the cement, and the resistance of the built up material is practically equal to that of pure mica.

Machinery has been designed for the rapid manufacture of the material, and one operative can produce 20 cu. ft. per hour. As the cost of the small sizes of mica which are used is very little, the product can be marketed at a moderate figure, and is expected to be applied to a wide range of uses.

A great dock building enterprise at Buffalo is reported, having for its object the improvement of a lake frontage of 30,000 ft., extending from Tifft St. to Stony Point, by the building of docks, warehouses, and a system of railway terminals. The promoters are said to be enlisting New York capitalists in the enterprise.

Brick paving is to be tried in Glasgow. It is in common use in some Continental towns, but the difficulty of procuring the right kind of material in England for the manufacture of bricks of a sufficient hardness and toughness has prevented that form of paving being tried. Proper material has, it is said, now been found near Braidwood, and the bricks are to be manufactured by the Omoa Fireclay Co., which is erecting new works for the purpose. While the material is called a clay, it is in reality an imperfect hematite ore, and requires to be quarried.

There are now 4,350 miles of railway in construction in Spain. Almeria, Soria and Teruel are the only provincial capitals that have not yet been brought into connection with the general railway system, but nearly two-thirds of the principal towns of the various districts of the 49 provinces are also isolated, while only one-third of the 52 strategic points that could be used to defend Spanish territory are at present provided with railway communication. The total number of locomotives is 1,200; passenger cars, 4,000; and freight cars, 16,000. There are 11,280 miles of highways, 2,500 miles are in process of construction and plans for 620 miles more have been approved. It is intended to have the general highway system ultimately consist of 22,300 miles. The number of bridges possessed by Spain is as follows: Stone, 1,062; iron, 35; and wood, 72. The number of each of these three classes now in process of construction is 98, 24 and 3, respectively.

The Midland Railway Co., of the colony of Western Australia, is hampered by the failure of the colonial government to give it the land provided by the land grant. There are 150 miles built, but owing to the failure of the government to turn over the deeds of the land, according to the concession, the company, which is an English concern, is not able to dispose of the land properly belonging to it, and is, therefore, unable to raise funds for completing the line. There are 150 miles in operation, and 50 miles more were required to be completed by February, 1893, and the government is said to have hindered the work with a view to forfeiting the concession. Such a proceeding is very strongly deprecated by the English press and, if carried out, will badly damage the reputation of the colony. Meanwhile, the company is running trains on the completed line, to fulfill the requirements of the concession and is carrying on negotiations with the government, maintaining its right to the lands and to an extension of the date for completion of the railway, the delay having been caused by the government and not by the company.

Whaleback steel boats are to be built to the amount of $4,000,000, says Captain McDougall, President of the American Steel Barge Co., of West Superior, Wis. This means two years' work at full capacity of the present yards.

Car heating by hot water has been introduced on some of the express trains of the Midland Railway, of England.

The complete reports of the recent armor plate tests in Prussia show a great superiority for the Harvey process plate made by Vicker & Co. Four shots were fired at this plate from a 6-in. gun, with velocities of 2,173 ft. per second; 90-lb. Holtzer projectiles were used. Each shot penetrated 4 to 5 ins., and the base broke up and scattered. None of the shots produced any cracks. It was agreed by the testing board that as none of these shots had done any injury to the plate the competition should be considered closed. To test further the resistance of the plate, however, it was determined to fire two 9-in. shells at its face. The projectiles used were of steel, weighing 406 lbs., and the first had an initial velocity of 1,655 ft. per second. This penetrated and broke up, cracking the plate seriously and causing cracks to radiate from the previous shot holes. No part of the plate fell from the backing, however. The second 9-in. shot fired at a velocity of 1,889 ft. per second was broken by the concussion, but completely wrecked the plate and backing. The shell just pierced the wrought iron of the backing and set the wood behind it on fire. The other plates tested were a low French carbon nickel-steel plate, made at St. Chamond, a Brown compound plate with surface hardened by the Tressidder process, and two nickel-steel plates made by Commell & Co., of Sheffield. The St. Chamond plate showed the best results of these plates, and the Cammell low carbon-nickel steel was a good second. The Tressidder plate was destroyed in three shots and the Cammell high carbon in five.

ELEMENTS OF WEATHER IN THE UNITED STATES OF MOST INTEREST TO ENGINEERS FOR THE MONTH OF NOVEMBER, 1892.

[Furnished to Engineering News by the Department of Agriculture.]

	Station.	Temperature. (Deg. Fahr.)				Wind.			Precipitation—(Rain and melted snow)—inches.		
						Velocity in miles per hour.		Direction at time of max. velocity.			
		Average	Max.	Min.	Range.	Average	Max.		Total.	Heaviest in 24 hours.	No. of rainy days.
Northern Cities.	Northfield, Vt	32.8	63	11	52	9.1	52	S	3.43	0.90	17
	Portland, Me	37.2	63	13	50	9.1	44	S	3.76	1.16	12
	New York City	42.6	66	24	42	12.5	40	NW	8.28	3.62	13
	Pittsburg, Pa	41.6	72	18	54	8.4	30	S	1.81	0.46	19
	Chicago, Ill	34.7	58	12	46	17.8	55	SW	2.68	1.43	12
	Omaha, Neb	38.0	68	15	53	8.8	33	NW	0.14	0.06	3
	St. Paul, Minn	27.6	52	1	51	8.6	35	W	0.36	0.23	6
	Duluth, Minn	30.4	46	-4	50	8.1	34	N	1.69	0.76	9
	Bismarck, N. Dak	25.7	57	-4	61	11.0	50	NW	0.66	0.30	11
	Average	34.1	60.6	9.6	51.0	10.4	41.4	.....	2.53	0.91	11
Southern Cities.	Washington City	43.7	71	22	49	8.0	38	NW	3.38	1.29	12
	Louisville, Ky	42.8	70	16	54	7.7	36	SW	2.87	0.54	15
	St. Louis, Mo	41.5	67	22	45	11.9	43	SW	3.46	1.41	9
	Savannah, Ga	57.0	82	30	52	7.1	28	NW	1.30	0.69	7
	Leavenworth, Kan	40.7	66	21	45	9.0	42	NW	1.53	1.02	5
	Jacksonville, Fla	59.9	85	35	50	6.4	24	E	0.64	0.29	6
	Chattanooga, Tenn	48.0	74	22	52	5.1	28	SW	6.32	1.36	12
	New Orleans, La	62.1	83	41	42	8.9	36	N	3.55	1.26	7
	Memphis, Tenn	49.6	76	25	51	8.1	50	SW	6.26	1.42	12
	Palestine, Tex	60.2	82	34	48	6.8	27	NW	5.99	2.77	8
	Average	51.6	75.6	25.8	48.8	7.9	35.2	.....	3 53	1.20	9
Western Cities.	Helena, Mont	36.9	63	-4	67	10.4	56	SW	2.05	1.27	12
	Port Angeles, Wash	43.3	56	31	25	5.5	34	W	8.18	2.43	22
	San Francisco, Cal	56.9	78	42	36	9.1	56	SE	3.91	1.46	7
	Salt Lake City, Utah	42.2	60	18	48	7.5	36	S	0.72	0.68	2
	Denver, Colo	42.9	70	19	51	8.8	36	NW	0.41	0.44	2
	Yuma, Ariz	63.1	85	38	47	5.4	24	N	0.00	0.00	0
	Santa Fé, N. Mex	38.5	57	17	40	7.3	35	NW	0.36	0.19	3
	Average	53.4	67.9	23.0	44.9	7.7	39.6	.....	2.24	0.92	7

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago.—Existing Roads.

BALTIMORE & LEHIGH.—This company has contracted with the Baltimore Forwarding & R. R. Co. for the operation of the Baltimore & Lehigh R. R. from Baltimore to York, Pa., 79 miles. The track will be changed to standard gage, and other improvements will be made at an estimated cost of $1,500,000.

OHIO SOUTHERN.—About 150 men are at work on the Springfield-Lima extension, near Springfield, O., and about two miles of grading are completed.

PITTSBURG, CINCINNATI, CHICAGO & ST. LOUIS.—The 7-mile branch from McDonald and Bridgeville, O., has been completed and opened for traffic.

OHIO & MISSISSIPPI.—It is announced that this railway will be extended to Bedford, Ind., to connect with the Bedford Belt Ry., now under construction, and thence north to a connection with the Evansville & Indiana and Chicago & Illinois railways.

NORTHERN CENTRAL.—The newspapers state that this company is considering an extension from Canandaigua to Buffalo, N. Y.

WHEELING & LAKE ERIE.—A 3-mile spur from Martin's Ferry to Altuaville, O., will be built at once. There will be a large amount of wooden trestle-work.

Projects and Surveys.

EASTON & CHESTERTON.—A railway from Easton to Chesterton, Md., along the east shore of Chesapeake Bay, is being agitated.

MANCHESTER & MAPLE GROVE.—A company has been organized to build a railway from Manchester, Pa., to Maple Grove, Md. Its officers are; Pres., Jacob A. Frederick; Vice-Pres., Wm. H. Shower; Sec., C. J. H. Gauter, and Treas., Edward Oursler.

NEW HAVEN & DUNBAR.—Chartered in Pennsylvania to built a railway from Dunbar Creek to a point on the Pittsburg, McKeesport & Youghiogheny R. R., 4 miles. Pres., Frank A. Hill, Dunbar, Pa.

Southern.—Existing Roads.

OWENSBORO, FALLS OF ROUGH & GREEN RIVER.—Only about four miles of track remain to be laid on the line from Fordsville to Horse Branch, Ky.

GULF OF MEXICO & TENNESSEE.—This company has been chartered in Tennessee to build a railway from Jackson, Tenn., to Middleton, Tenn., 41 miles. It is stated that the company has secured an option on the Gulf & Chicago R. R., from Middleton, Tenn., to Pontotoc, Miss., 62.5 miles, and also on the Gulf & Ship Island R. R., from Gulfport, Miss., north, 20 miles, and will connect the two roads over the old projected route of the Gulf & Ship Island R. R.

Projects and Surveys.

CUMBERLAND.—Chartered in West Virginia to build a railway from Cumberland, Md., to Moorfield or Petersburg, W. Va. Principal office, Keyser, W. Va. Incor-

portors: J. A. Mulholland, C. A. Wilson, R. U. S. Moore, and H. Hebb, of Cumberland, Md., Jas. Parsons, Davis, W. Va., and T. B. Davis, Keyser, W. Va.

COAL RIVER.—At a recent meeting of the projectors of this West Virginia Railway, a proposition was submitted by J. S. Casement, of Painsville, O., in which he agrees to build 50 miles of the road on condition that the land owners along the route donate 500 acres of land per mile. The proposition was considered favorably, and the prospects are good for the early construction of the road.

DUNNELLON PHOSPHATE CO.—This company, it is stated, will build a railway 15 miles long to connect with the Ambler Lumber Co.'s railway at Early Bird, Fla.

NATCHEZ & PASCAGOULA.—Chartered in Mississippi to build a dummy railway from Moss Point and Scranton to Pascagoula Bay, Miss.

POINT PLEASANT, BUCKHANNON & TYGART'S VALLEY.—Chartered in West Virginia to build a railway from a point at or near the town of Belington, in Barbour Co., running through the counties of Barbour and Upshur, to a point at or near Buckhannon, Upshur Co., thence through Lewis, Braxton, Gilmer, Calhoun, Roane and Jackson counties, to a point at or near Point Pleasant in Mason Co. The principal office will be at Buckhannon. The capital stock of the road is $1,000,000. The incorporators are: James H. Hanson, W. G. L. Latton, Crede W. Hart, William Post, Thos. S. Farnsworth, John A. Crislip, Samuel C. Rusmisell, Jacob G. Hall, John L. Hursh, and Jacob W. Hearener, of Buckhannon, W. Va., and Charles J. Goff, of Clarksburg, W. Va.

Northwest.—Existing Roads.

DULUTH & IRON RANGE.—The total cost of the extensions to the company's docks at Duluth, Minn., will be about $280,000. The contracts for the addition of 90 pockets to dock No. 2, and a 500-ft. extension to dock No. 4, have been let to Winston Bros., and R. B. Dear. The contract price is $165,000, exclusive of material, which will bring the cost up to about $250,000. The company itself will add 18 pockets to dock No. 1 at a cost of about $30,000.

BURLINGTON, CEDAR RAPIDS & NORTHERN.—The extension from Forest City, Ia., west to Estherville, Ia., has been completed as far as Reynolds, Ia., 39 miles, and work has stopped for the winter. It is probable that the line will be continued to Estherville next season.

Projects and Surveys.

CHICAGO & CALUMET VALLEY.—Chartered in Illinois to build a railway from the southern part of Chicago to Lemont Township, Cook Co., Ill. The incorporators are: John G. Campbell, C. V. Smith, John Barton Payne, Wm. Brace, and Henry A. Ritter.

NORTHWESTERN COAL & RY. CO.—Chartered in Wisconsin to build a railway from a point on Allouez Bay, near the mouth of Newadji River, to the Minnesota line in Sec. 1, Twp. 48, Range 14, Douglas Co., a distance of 12 miles. Incorporators: E. N. Saunders, E. L. Booth, and others, of St. Paul, Minn.

Southwest.—Existing Roads.

CHICAGO, ROCK ISLAND & PACIFIC.—It is announced that this company has expressed its intention to build a line from Atchison to Pierce Junc., Kan., next Spring.

Projects and Surveys.

LOUISIANA, ARKANSAS & MISSOURI.—It is stated that contracts for the line from Trippe, Ark., to Bryan City, La., noted in our issue of Dec. 22, 1891, will be let about April 1, 1893.

BOUTTE & HAHNVILLE.—Chartered in Louisiana to build a railway from Hahnville, La., to Boutte, La. Directors: Chas. E. Rice, Thos. Lully, Jas. Leguidre, of New Orleans, La., John A. Morris, Westchester, N. Y., Morris R. Bein, Parish of St. Charles, La.

LEAVENWORTH.—Chartered in Kansas to build a railway from Fort Leavenworth, Kan., to Lansing, Kan., 40 miles. Among the directors are: Harry L. Earle, Leavenworth, Kan.; E. O. McNair, Warsaw, N. J.; H. L. Turner, Chicago, Ill., and A. B. Nettleton, Minneapolis, Minn.

TEXAS, SABINE VALLEY & NORTHWESTERN.—The stockholders will hold a meeting Feb. 13, 1893, to increase the capital stock, issue and execute new mortgage bonds to provide for the construction of the road. Secy., Wilbur F. Herbert, Jr.

Rocky Mountain & Pacific.—Existing Roads.

NORTHERN PACIFIC.—This company is preparing to build a branch from a point on the Seattle, Lake Shore & Eastern R. R. to Bellingham Bay, tapping the Blue Canyon coal mines on Lake Whatcom on the way.—The Washington papers state that the prospect for work being begun on the Burrard Inlet & Fraser Valley R. R. next spring is good. This line has been surveyed and will run from Sumas, Wash., to Vancouver, B. C., 43 miles. The estimated cost of construction is $1,000,000. The work will include a bridge 1,700 ft. long over the Fraser River, which will cost about $250,000.

NORTHERN PACIFIC.—The map of the definite location of the Northern Pacific & Montana R. R. Co.'s branch to the Flathead country has been filed with the Commissioner of the General Land Office at Washington. The road starts at a point on the main line of the Northern Pacific near Locke Station, and runs thence to the Flathead River, Crow and Mud creeks valleys; thence along the east shore of the Flathead Lake to the northern boundary of the Flathead Indian Reservation, 50½ miles. From the above point it runs along the shore of Flathead Lake northerly to a point near the mouth of Swan River, 12.76 miles; from the mouth of Swan River, north, up the valley of the Flathead River, 26.7 miles; thence up the valley of the Flathead River to a point on the left bank of Coal Creek, one mile above its confluence with the Flathead River, 28.1 miles. With the filing of the right of way is also filed the location of depot sites, etc.

CRYSTAL RIVER.—A force of about 600 men are now at work on the Colorado railway. The road, when completed, will be 46 miles long, 34 miles from Carbondale, Colo., up Crystal River and 12 miles of branches on Coal Creek. Six miles have been graded and five miles of track laid. The contracts require the completion of the road by April 1. The cost of construction and equipment will be about $1,000,000. The track is standard gage, laid with 57-lb. steel rails.

GREAT SALT LAKE & HOT SPRINGS.—This company announces that it will extend its line to the coal mines near Coalville, Utah.

SOUTHERN PACIFIC.—It is stated that right of way is now being secured for the proposed branch from Colton to Riverside, Cal.

Projects and Surveys.

COLUMBIA RY. & NAVIGATION CO.—This company has received proposals for the construction of a portage railway 22 miles long around The Dalles of the Columbia River. Rock excavation is to begin Jan. 15 and be completed May 15, and the entire work to be completed July 15. Ch. Engr., Emery Oliver, The Dalles, Ore.

SALINA & DEEP CREEK.—Chartered in Utah to build a railway from Salt Lake City, Utah, to Muncy, Nev., 223 miles.

Foreign.

MEXICO, CURRUEVACA & PACIFIC.—A preliminary survey of this railway from the City of Mexico to the Pacific coast has just been completed. Its route will be from the City of Mexico via Corruevaca, Jajolta, Hutia, Solado, Jolapan, Jalapa, to Cuyagan, and thence across the divide and along the river to Ometpee and Paligada Bay. Ten miles of the line near the City of Mexico have been completed.

ELECTRIC RAILWAYS.

WORCESTER, MASS.—The Worcester, Leicester & Spencer Street Ry. Co. has applied to the Board of Aldermen for permission to extend its line from Webster Square along Knox and Clover Sts. to the Auburn line. The extension is said to be a part of a line to connect Worcester and Southbridge, Mass.

TROY, N. Y.—The Troy & Lansingburg Street Ry. will change the motive power of its line between Cohoes and Troy to electricity in the spring.

CHESTER, PA.—The Chester, Darby & Philadelphia Ry. Co., which proposes to build an electric railway from Chester to Philadelphia, Pa., will begin work at once. The trolley system will be used.

FREDERICK, MD.—An electric railway from this town to Hagerstown, Md., is talked of. Mr. Bosley, of Frederick, is interested.

CHATTANOOGA, TENN.—Another electric railway up Lookout Mt. is projected.

OWENSBORO, KY.—The Monarch Electric Car & Power Co. has been chartered to build an electric railway. R. Monarch, Wilfred Carico, M. V. Monarch.

TROY, O.—The Troy Electric Street Ry. Co. has been chartered to build an electric railway. Pres., Theo. Sullivan; Vice-Pres., J. C. Barry, Secy., John W. Morris; Treas., Chas. T. Ziegenfelder.

VALVERDE, COLO.—A company is to be chartered to build an electric railway connecting this place with Denver, Colo.

SPOKANE, WASH.—The Manhattan Co. has completed surveys for electric railways from Lakeside to Chelan Falls, 4 miles, and from Lake Chelan to mines, 22 miles. Pres., Steven E. Barton.

LONDON, ONT.—A syndicate, at whose head is Henry A. Everett, of Montreal, P. Q., has purchased the street railway system at this place, and will, it is stated, apply for a franchise to operate it by electric power.

HORSE AND MOTOR RAILWAYS.

WALLINGFORD, CONN.—An attempt is being made to induce the Meridan St. Ry. to extend its line to this place.

LOWELL, MASS.—The Lowell & Suburban Ry. Co. is considering an extension to Billerica Center.

HIGHWAYS.

NEW YORK.—A meeting has been held at Dunkirk to consider the laying out of a highway to Cherry Creek, Sheridan, Arkwright and Villenova. L. F. Stearns, Martin Town, J. T. Williams and George Warner were appointed a committee to draft a bill to be presented to the legislature providing for the power to lay out the highway. It is said that not more than three miles of the new road will be necessary, the cost of which, it is believed, can be met by private subscription.

PENNSYLVANIA.—The citizens of Tinicum township voted on Thursday last on the question of bonding the township for $18,000 for public road improvements. The vote was in favor of the loan by a good majority. The work will be given out at the lowest bid.—It is proposed to macadamize the principal roads of Abington township, at a cost of $6,000 a mile.

BRIDGES, TUNNELS AND CANALS.

BOSTON, MASS.—Plans for a tunnel under Boston harbor, connecting East Boston with the city proper, have been prepared by City Engineer William Jackson.

WATER-WORKS.

New England.

YORK, ME.—The York Aqueduct Co. has been incorporated; $100,000.

HANOVER, N. H.—It is stated that the Hanover Water Co. is arranging for the sinking of wells for a supply, and has voted to accept a proposition from the Connecticut Pipe Manufacturing Co. in connection with the construction of works. There will be a pumping station, stand-pipe, and perhaps 12 miles of mains. Pres., J. Dwelley; Clk., Eben C. Waterman; Treas., Alpheus Parkard.

LOWELL, MASS.—The contract for the cast iron pipe mentioned in our issue of Dec. 22 has been awarded to the Warren Foundry & Machine Co., New York, the lowest bidders.

SPRINGFIELD, MASS.—An additional supply main from the Ludlow Reservoir is proposed, to include about 25,000 ft. of 36-in. and 42,000 ft. of 40-in. iron and steel pipe; estimated cost, $370,000.

MIDDLETOWN, CONN.—Engr. Geo. H. Bishop has recommended the construction of two storage reservoirs and a supply conduit; estimated cost, $215,000.

Middle.

HIGHLAND, N. Y.—Address A. D. Lent regarding proposed works.

NEW YORK, N. Y.—The Aqueduct Commissioners have accepted the estimate of Chf. Engr. A. Fteley for constructing the East Branch Reservoir, at a cost of $436,490.

ROCHESTER, N. Y.—The lowest bids for constructing the new supply conduit were as follows: 12,000 ft. masonry conduit, 6 to 6½ ft. high and wide, Wm. H. Jones & Sons, Rochester, $292,518, with 225 days for completion; 26½ miles of riveted steel pipe, Moffett, Hodgkins & Clarke, New York, for 38-in. pipe on Route B, $847,553, or for 40-in. on Route B, $883,473, with 400 days for completion; furnishing 26½ miles of 36-in. cast iron pipe, as alternative to steel (one bid), from five manufacturers, combined, of $640,800, with 365 days for delivering to Mt. Hope Reservoir; laying 26½ miles 36-in. cast iron pipe (one bid), Whitmore, Rouber & Vicinus, Rochester, $536,255, for Route B, or $532,210 for Route A, with 450 for completion to Mt. Hope reservoir. The total of the lowest bids, with steel pipe, is $1,175,991 for 40-in., and $1,140,071 for 38-in. pipe; with cast iron pipe the total would be $1,469,553, following Route B in either case.

SYRACUSE, N. Y.—The Eddy Valve Co., Waterford, N. Y., have been awarded the contract for valves and hydrants for this year for $42,185.

ATLANTIC CITY, N. J.—The city has bought the works of one company and the council has just voted to buy those of the other, at a total cost for both plants of $750,000.

COLLINGDALE, PA.—The Collingdale Water Co. has been incorporated; $1,000; Treas., W. Y. Hooper, Media; Directors, Jas. S. Perot, Jr., Jos. S. Keen, Jos. W. Hawley and H. Bayard Hodge.

DUQUESNE, PA.—Works are advocated by the "Observer."

EDDYSTONE, PA.—The Eddystone Water Co. has been incorporated; $1,000; Treas., W. Y. Hooper, Media.

ERIE, PA.—The contract for a brick pumping station, 36 × 56 ft., has been awarded to Constable Bros., for $7,000. Henry Shenk bid $9,490 and W. A. Lloyd, $11,578.

GIRARD, PA.—The borough has voted $19,000 of bonds for works.

INGLESIDE, PA.—The Ingleside Water Co. has been incorporated; $2,000; Treas., Geo. M. Hill; Directors, H. W. Brackenridge, Natrona; D. B. Golden, Freeport, and others.

PHILADELPHIA, PA.—The sum of $420,000 has been appropriated for extension, including $40,000 for boilers, $25,000 for boiler house, $40,000 for engine and boiler house, $151,000 for high service station and the balance for 48, 30 and 20-in. pipe.

PINE GROVE, PA.—At the spring election the people will vote on incurring a debt of $26,000 for works. Town Clk., F. B. Wheeler.

WEST NEWTON, PA.—The Highland Water Co. has applied for a charter. E. G. Smith, P. W. Morgan and others are interested.

Southern.

HUNTSVILLE, ALA.—A 40 × 60-ft. stand-pipe will be built for the city by M. A. Castor, Birmingham, for $7,138.

CHATTANOOGA, TENN.—It is said that the Chickamauga Land Co. thinks of introducing a rival supply from Crawfish Springs, owned by the company, and that Simon Borg, of Borg & Co., New York, is interested.

North Central.

CLEVELAND, O.—The Dir. Pub. Wks. Herrick, has been authorized to advertise for bids for pipe for 1893.

CLEVELAND, O.—Jas. Sargent, Rochester, N. Y., recently bid $2,995 for smoke consumers and the Murphy Iron Works, Detroit, $6,083.

NEW CUMBERLAND, O.—It is said that works are talked of.

EDINBURG, IND.—Bids for works will be received until Jan. 21. There will be two miles of mains, 15 hydrants, wells, pumping plant and a stand-pipe.

ALABASTER, MICH.—It is said that works will be built in the spring.

NILES, MICH.—It has been estimated that a second plant could be built for $80,000.

Northwestern.

DILLON, MONT.—Engr. F. E. Blackfoot has reported to the Council on works: estimated cost of gravity system, $50,000.

Southwestern.

GROESBECK, TEX.—It is said that works will be built.

MARBLE FALLS, TEX.—Isaacs, Gorman & Johnson are interested in water-works, an electric plant and ice factory, which, it is said, will be established here.

CLAYTON, TEX.—The Clayton Electric Light and Water Supply Co. has been incorporated to operate works; $20,000. The Union Pacific Railway Co. built works here in 1886.

Pacific.

BALLARD, WASH.—The Manufacturers' Water Co. has been incorporated; $12,000; David McVey, A. F. McEwen, and C. D. Stimson.

ELBERTON, WASH.—It is stated that works will be built in the spring.

WHATCOM, WASH.—It is said that the city has voted to buy the private works for $147,000, and to spend $103,000 for improvements.

CORVALLIS, ORE.—The city has bought the works for $28,000. Engr. Kelley, of Eugene, has made plans for $25,000 to $30,000 improvements.

INDEPENDENCE, CAL.—The new Stevens Ditch Co. has been incorporated; $45,000. It is said that the company will operate water-works, but it is more probably an irrigation company, especially as works were built here in 1887.

SAN DIEGO, CAL.—It is reported that the San Diego Flume Co. will build a 760,000,000 and a 15,000,000-gallon reservoir, the smaller one for city water supply and the larger one for irrigation.

IRRIGATION.

ROCKY FORD, COLO.—Bids will be received by the High Line Canal Co. until Jan. 14 for the construction of a pile dam across the Arkansas River, about 2¼ miles from Boone station, on the Atchison, Topeka & Santa Fe R. R. The dam will be about 400 ft. long and will require about 150 piles and 70,000 ft. of lumber. G. M. Hall, Secy.

SEWERS.

FAR ROCKAWAY, N. Y.—The Shone hydro-pneumatic system of sewerage and the gravity system are under discussion. The latter was before the people at a special election last spring, but the plans of the commissioners were rejected. It will be necessary to erect disposal works, as by a decision of the State Board of Health

the village cannot empty its refuse matter into the bay or the ocean. This will increase the expense by about $65,000.

NEWBURG, N. Y.—C. Caldwell, Cy. Surv., informs us that the proposed main trunk sewer, to drain the western portion of the city, will be 2.5 miles in length, drain about 750 acres and cost about $150,000. If the legislature authorizes the construction, the work will probably be commenced next summer. The Sewer Committee has reported in favor of two lateral sewers.

ROCHESTER, N. Y.—The contract for Section 4 of the East Side trunk sewer has been awarded to Wm. Fuller, of Rochester, at $71,881. This section extends from Bay to Clifford St., a distance of over a mile. The contract for Section 7 was awarded to Weider & Voltz, at $2,408. Section 7 extends from a point opposite Henrietta Ave. about 13 0ft. under the Erie Canal. Engineer Peacock is nearly ready to receive bids for Section 6, which will take the work from the river to the canal.

COLUMBIA, S. C.—The South Carolina Sewerage Co. is to be organized to build sewers, and the city may be authorized to issue 6% bonds for the work. Capital stock, $30,000. John T. Sloan, Jr., H. C. Patton and T. T. Moore are interested.

BRUNSWICK, GA.—The construction of a sewerage system is being urged; estimated cost, $60,000.

NASHVILLE, TENN.—Jas. A. Jowett, Cy. Engr., sends us the following information: The City Council has included in the budget for 1893 the sum of $400,000 for sewerage purposes. In order to provide this sum it will be necessary to obtain the authority of the legislature to issue bonds to this amount. If this is granted the work will be carried out in 1893. The sewers to be constructed will be principally main sewers built of brick, and will be advertised as soon as the work can be proceeded with.

INDIANAPOLIS, IND.—The Board of Public Works will receive bids until Jan. 23 for three main sewers and one local sewer: 6,377 ft. of 3-ft. to 5-ft. brick, 2,053 ft. of 4-ft. to 4-ft 3 ins. brick, 8,312 ft. of sizes from 26-30 in. to 5 ft. 6 ins., 1,916 ft. of 15-in. pipe to 26-30 in. brick. H. A. Mansfield, Cy. Engr.

WATERLOO, IA.—Chas. E. Oberholser, Cy. Engr., writes us as follows: The sewer matter is rather indefinite at present. Nine or ten blocks of main sewer and bulkheads were advertised last autumn, but as only one bid was received it was rejected. It is very probable that the contracts will be relet next spring. Main sewers are to be of brick from 22 × 33 ins. to 48 ins. in diameter; cuts, 10 to 12 ft.

SIOUX FALLS, S. DAK.—We are informed by J. M. James, Asst. Aud., that the city contemplates the construction of sewers, to cost about $150,000, and that bids will be received by him until Jan. 16 for a part of the construction.

GLENWOOD SPRINGS, COLO.—The estimated cost of a system of sewerage is $13,000.

SALT LAKE CITY, UTAH.—A. F. Doremus, Cy. Engr., sends us the following information: The City Council has recently authorized the construction of the gravity trunk sewer, which will be about five miles long, from 3 to 5 ft. in diameter, and will cost, including sewerage farm at outfall, about $325,000. The work will be commenced as soon as the weather will permit.

STREETS.

JENKINTOWN, PA.—The contract for five squares of macadamizing has been awarded to C. F. Stauber, of Wayne, Pa.

COLUMBUS, O.—N. B. Abbott has been awarded the contract for paving Champion Ave., from Livingston Ave. to Schiller St., with Hallwood block, with tar filling; estimate, $16,618.50.

DEFIANCE, O.—About two miles of brick paving will be constructed next spring.

ELYRIA, O.—We are informed by L. C. Kelsey, Cy. Clk., that the city proposes to have a portion of Broad St. and East Bridge St. paved with brick, the work to commence in the spring.

MUNCIE, IND.—We are informed that the city will do considerable paving, the work to begin early next spring.

GOSHEN, IND.—We are informed by I. D. Wolfe, Cy. Clk., that the city proposes to construct about 11 blocks of street paving.

CRESTON, IA.—J. Knox Hall, Cy. Clk., writes us that proposals for paving will be advertised for this month.

BURLINGTON, IA.—William Steyh, Cy. Engr., sends us the following: The city had under contract Dec. 1, when work was stopped, about 40,000 sq. yds. of brick pavement, work on which will be resumed early the coming spring. Bids were opened Sept. 7 for 25,000 sq. yds. more, but no contracts have been awarded yet. The prices range from $1.53 to $1.65 per sq. yd. and the number of bids received from four to six, all of the bidders residing in that city.

WATERLOO, IA.—We are informed by Chas. E. Obuholsen, Cy. Engr., that last summer the city awarded contracts for the paving of eight blocks to Henry Bessler, Cedar Rapids, but that the scarcity of brick delayed work, so that only four blocks are done. There will probably be six or eight blocks more let next summer. The city uses Galesburg brick and cement curb, but it is thought that stone curb will be adopted for use on business streets.

ST. LOUIS, MO.—It is proposed to pave Easton Ave. a distance of three miles with asphalt.

BEATRICE, NEB.—A special election will be held Jan. 24 to vote on the issue of bonds for $20,000 for new paving.

MONTREAL, QUE.—The list of streets to be paved next year includes nine with asphalt and four with block stone.

MONCTON, N. B.—About 2,000 sq. yds. of block paving were laid last summer at a cost of about 80 cts. per sq. yd. It is proposed to contract this winter for blocks to be used next summer.

ELECTRICAL.

ADDISON, N. Y.—Bids are asked for erecting and operating an electric light plant for a period of five years.

NEW YORK, N. Y.—A contract has been given to the Thomson-Houston Electric Light Co. for lighting 45 lamps at 40 cts. a night each, for one year from Jan. 1, 1893, the lamps being in 8th St., Bowery, 14th to 42d Sts., and 4th to 6th Aves. A contract for 17 lamps at 40 cts. a lamp, was awarded to the Manhattan Electric Light Co. for lamps between 41st and 59th Sts. in Madison Ave. The Edison Electric Illuminating Co. has the contract for 57 lamps, at 50 cts. each, in 5th Ave., between Washington Square and 60th St.

FLATLANDS, N. Y.—The Flatlands Electric Light and Power Co., recently incorporated, has petitioned the town board for a franchise.

ELIZABETH, N. J.—The Suburban Electric Co. has a contract for 25 to 75 arc lights for three years, at $1.25 per light.

COLUMBUS, GA.—It is reported that an electric light plant will be erected by F. W. Prescott & Co., New York.

TAMPA, FLA.—W. D. Wilson, Tarpon Springs, is considering the erection of a plant.

BURLINGTON, IA.—C. H. Walsh, Man. Burlington Electric Lighting Co., sends us the following particulars of the new plant: The boiler room is 58×117 ft. and contains eight boilers, aggregating 720 HP. The dynamo and engine room is 68×117 ft., and contains a Sioux City 350-HP. Corliss engine; 3 arc dynamos, 50 lights each; 3 incandescent dynamos, 2,000 1,000 and 600 lights each; 2 Deane pumps; 1 heater, 900 HP., and a switchboard 24×11 ft. The company has about 80 miles of wire. It supplies steam heat for about 3,000,000 cu. ft. of radiation, and has about two miles of mains. High pressure is used on the boilers for both heat and light and the exhaust steam is used for heating purposes during the night.

JONESBORO, ARK.—The Jonesboro Power Co. has been incorporated for the purpose of erecting an electric plant, etc.; Pres., G. W. Ducker, Newport; Treas., S. A. Warner, Jonesboro.

LEXINGTON, NEB.—The citizens have voted to issue bonds for electric light.

MADISON, NEB.—We learn from J. S. Cleveland that the city will issue bonds for $3,500 and put in, in addition to the water-works plant, a 25-HP. boiler, 45-HP. engine, 20 arc and 100 incandescent lights, with 2½ miles of wire.

PALOUSE, WASH.—The Palouse City Electric Light & Power Co. has been incorporated by C. T. Cross, Andrew Clyde and others; capital stock, $30,000. The company has a 150-HP. engine and dynamos for 1,000 incandescent and 50 arc lights.

NEW COMPANIES.—Globe Storage Battery Co., Chicago, Ill.; $1,000,000; J. H. Wheeler, Sigmund Kapij, Louis Dumas. Chicago Electric Light Headlight Co., Chicago, Ill.; $100,000; Geo. S. Foster, John T. Van Smith, Y. A. Halverson. Nevada Light Co., Kansas City, Mo.; $100,000; A. E. Stillwell, A. A. Masher, G. L. Farrell.

CONTRACT PRICES.

SEWERS.—Los Angeles, Cal.—We have received from J. H. Dockweiler, City Engineer, the list of bids for sections 1, 2, 4, 5, 7, 8 and 9, of the brick outfall sewer, and contracts have been let as follows: Sec. 1, John Rebman, Los Angeles, $12,012; Sec. 2, Frick Bros., Los Angeles, $24,035; Sec. 4, J. L. Mansfeld, Los Angeles, $4.25 per lin. ft., $60 per manhole, $150 per chamber, $26,830; Sec. 5, Frick Bros., $25,730, $3 per ft. extra for solid rock in tunnel, 60 cts. per extra excavation; Sec. 7, Frick Bros., $27,454; Sec. 8, Hughes & Mayer, Pasadena, $24,602; Sec. 9, Frick Bros., $11,216, exclusive of tunnels, $8 per lin. ft. for earth or crumbling rock and $11 per lin. ft. for solid rock in tunnels, $22,223 in all. Sections 3 and 6 are the wooden stave pipe inverted siphons, but bids for these and for the cast iron pipe to be built out into the ocean have not yet been called for. On Sec. 9 it is assumed that one-eighth of the total length will be in solid rock one-eighth in crumbling rock and three-quarters in earth.

Racine, Wis.—We are informed by C. F. Kohlman Cy. Engr., that contracts for two brick sewers have been awarded to Jas. Cope, Racine, at the following prices: Two wooden outfalls, $1,810 and $895; 5-ft double ring, circular, 1,570 lin. ft., $9 and $11 per lin ft. for tunnel and open cut, respectively, and 1,246 lin. ft. at $10 and $15; 4½-ft., 1,510 lin. ft., open cut, $8; 4-ft., 780 ft., open cut, $6; 13 manholes, $90 each, and 5 at $100; two catch basins, $50 each.

Fort Wayne, Ind.—The contract for the brick sewer in 19 ft. depth of sand and gravel excavation has been awarded by F. M. Randall, Cy. Engr., to Wilding & Derheimer, of Fort Wayne: 5,400 lin. ft. of 6-ft. brick sewer, at $6.79 per ft., $36,666; 285 vertical feet of manholes, at $2, $570; 24 catch basins, at $25, $600; 350 lin. ft. of 12-in. connections, at 70 cts., $245; 32 cu. yds. masonry, at $8, $256; total, $38,337.

PIPE LAYING.—Sioux City, Ia.—The following bids have been received for laying 60 tons of 8-in. water pipe, two 8-in. valves, three 6-in. hydrants, and 1,700 lbs. of special castings, the first bid in each case being for carrying the pipe across the Floyd River on the bridge, and the second bid being for submerged pipe: Meridith & Peters, pipe, $47.25 and $53.75 per ton; valves, $29.50 each; hydrants, $44.75 each; castings, 3.5 cts. per lb. Johnson & Magner, pipe, $48 and $47; valves, $33; hydrants, $45; castings, 3 cts. E. J. Hanlon, pipe, $52 and $54.90; valves, $24; hydrants, $45; castings, 3 cts.

PIPE—Salt Lake City, Utah.—The contract for 163 tons of 8-in. and 50 tons of 6-in., cast-iron pipe has been awarded to Rhodes Bros., at $35 per ton on cars at Salt Lake City.

Brookline, Mass.—A contract has been awarded to R. D. Wood & Co., Philadelphia, Pa., at $24.90 and $25.10 per ton for pipe, and $53.74 per ton for castings.

BRICK PAVING.—Anderson, Ind.—The streets are being paved with brick at a cost of $1.73 per sq. yd.

MISCELLANEOUS.

SEA WALL.—Tompkinsville, N. Y.—The lowest bid received Dec. 21 by Maj. D. P. Heap, U. S. Lighthouse Engineer, for the masonry sea wall, described and illustrated in our issue of Dec. 15, was from Thos. J. Gilroy, New York, N. Y., $33,277, being $2,621 for cofferdam, $9,756 for concrete, and $20,900 for stone wall. There were nine bidders, the highest being $71,300.

CULVERT.—Radford, Va.—Proposals will be received until Jan. 10 for a stone culvert across Connolley's Branch, at First St., and filling in to street grade. Plans and specifications on file in the office of W. J. Smith, Cy. Engr.; G. T. Keatsley, Chn. of St. Comm.

DREDGING.—Oakland, Cal.—Government contracts for dredging two channels, about 5,000 ft. and 4,000 ft. long, in the harbor, have been awarded to the Humphreys Hydraulic Dredging Co.

Brooklyn, N. Y.—The government has annulled the contract recently let for dredging in Gowanus Bay, and will readvertise the work.

DRAINAGE DITCH.—The greater part of the work on the Nogle ditch in Huron and Crawford Cos., O., has been let to W. C. Mobley, of Akron, O., at $10,270. The ditch will be 45.8 ft. wide at top, 30 ft. at bottom and 9.8 ft. deep. A floating steam dredge will be used.

FIRE HOSE.—Brooklyn, N. Y.—The Commissioner of the Fire Department will receive bids until Jan. 12 for hose, as follows: 2½-in. cotton, 6,000 ft.; 2½-in. rubber, 5,000 ft.; 3½-in. cotton, 1,500 ft.; 3½-in. rubber, 1,500 ft.

GAS LIGHTING.—Elizabeth, N. J.—The City Council has awarded the contract for lighting the city for three years to the Elizabethtown Gaslight Co., for $17.50 a lamp, to burn all night. This is $4 more per lamp than the lighting cost during the past three years. The New York Globe Gaslight Co. bid $19 per lamp.

NATURAL GAS.—Butler, Pa.—The Citizens' Gas Co. has been organized, with a capital stock of $50,000, and owns two good gas wells. Contracts have been placed for six miles of 3-in. and 4½-in. pipe. Pres., Peter Schenck; Secy., T. M. Baker.

MANUFACTURING AND TECHNICAL.

LOCOMOTIVES.—The Schenectady Locomotive Works, Schenectady, N. Y., have orders for 5 ten-wheel freight engines for the Chicago, St. Paul, Minneapolis & Omaha, 9 mastodon or twelve-wheel engines for the Duluth & Iron Range, and 6 narrow gage engines for the Colorado Midland. The Portland Co., Portland, Me., is building a snow plow for the Rumford Falls. The Grant Locomotive Works, Chicago, Ill., have an order for 25 ten-wheel engines for the Chicago, Burlington & Quincy. The H. Dudley Coleman Machinery Co., New Orleans, La., wants a logging engine, to run on 30 to 40-lb. iron rails.

CARS.—The Ensign Manufacturing Co., Huntington, W. Va., is building 200 gondola cars of 60,000 lbs. capacity for the Cleveland, Akron & Columbus. The Michigan Peninsula Car Co. has an order for 700 freight cars for the Atchison, Topeka & Santa Fe. The Portland Co., Portland, Me., is building 2 baggage cars for the Monson River. The Pullman Palace Car Co., Chicago, Ill., is building several sleeping cars for the Grand Trunk, for the World's Columbian Exposition traffic. Wells & French, Chicago, Ill., have a contract for 450 freight cars, with air brakes and automatic couplers, for the Duluth & Iron Range.

CAR TRUCK.—The Brooks Safety Car Truck Co. has been organized at Chippewa Falls, Wis., by A. Brooks, Phillip Loewe and J. T. Connors, to manufacture the Brooks patent car truck. Capital stock, $2,000,000.

ELECTRIC LAMPS.—The Westinghouse Electric & Mfg. Co., Pittsburg, Pa., has announced the prices of its new separable lamps, which, it is claimed, do not infringe the Edison patents. The list price will be 35 cts. for 25 and 20 c. p. lamps, and 30 cts. for 16, 10 and 8 c. p. lamps. The discount will be from 2½ to 10 per cent., according to the quantity ordered at one time, and 10 per cent. regularly to its central stations. The allowance for the delivery at its factories of the glass parts of such lamps will be 10 cents each, so that the net price of the 16, 10 and 8 c. p. lamps, which form nine-tenths of those used, will be 17 cts. each. The net price for 20 and 25 c. p. lamps will be 21½ cts. The efficiency of the 50-volt lamps is placed as high as 2½ watts per candle power. Another form of detachable electric lamp has been patented by F. H. Prentiss.

THE ABENDROTH & ROOT MFG. CO., 28 Cliff St., New York, have an order for 12,000 ft. of Root's patent spiral riveted pipe from the Mammon Gold Mining Co., Casa Grande, Ariz. Large quantities of the Root pipe are now used in the West for mining, irrigation and water-works construction purposes.

NEW COMPANIES.—Conneaut Construction Co., of Conneaut, O., organized at Hoboken, N. J.; $50,000; with $1,000 paid in; W. S. Chase, Hackensack, N. J.; F. H. Mollenhauer, Jersey City, N. J. Portland Cement Sidewalk Co., Chicago, Ill.; $10,000; W. R. Rennacker. Morgan Alcohol Time Signal Co., Ypsilanti, Mich.; $12,000. Adamantean Rock Paving & Fire Proofing Co., Denver, Col.; $25,000; James O. Triel, Herbert H. Mesere and Erkine W. Fisher. Mark Railway Equipment Co., Chicago, Ill.; $100,000; C. E. Mark, J. J. Hogan and J. W. Sykoria.

CURRENT PRICES.

RAILS.—New York: $29 at eastern mills; $30.75 at tidewater; old rails, $17 for iron, and $14 to $15 for steel. Pittsburg: $29; old rails, $21 for iron and $15.25 to $16 for steel. Chicago: $31; old rails, $18.75 for iron, and $12.75 to $15 for steel.

TRACK MATERIAL.—New York: steel angle bars, 1.6 to 1.65 cts.; spikes, 1.9 to 2 cts.; track bolts, 2.4 to 2.6 cts. with square and 2.7 to 2.8 cts. with hexagon nuts. Pittsburg: splice bars, 1.75 to 1.77 cts. for iron and 1.8 cts. for steel; iron and steel spikes, 2.15 cts.; iron track bolts, 2.7 cts. with square and 2.8 cts. with hexagon nuts. Chicago: splice bars, 1.65 to 1.75 cts. for iron and steel; spikes, 2.05 to 2.1 cts. at mill; track bolts, 2.6 to 2.7 cts. with hexagon nuts.

PIPE.—Cast iron, $20 to $30 per ton. Wrought iron, discounts as follows at Pittsburg: 50% and 10%, and 47½% and 10% on black and galvanized butt welded; 65% and 10%, and 55% and 10%, on black and galvanized lap welded. Casing, 57½%.

FOUNDRY PIG IRON.—New York: $13.25 to $15. Pittsburg: $13 to $14. Chicago: $13.25 to $14.25.

LEAD.—New York: 3.85 cts.; Chicago: 3.58 to 3.6 cts.; St. Louis: 3.5 cts.

STRUCTURAL MATERIAL.—New York: beams, 2 to 2.25 cts. for large lots, and 2.25 to 2.75 cts. for small lots; channels, 2.1 to 2.2 cts.; angles, 1.85 to 2 cts.; tees, 2.1 to 2.3 cts.; sheared iron plates, 1.85 to 2.1 cts.; steel plates, 1.85 to 2 cts. for tank, 2.1 to 2.25 cts. for shell, 2.4 to 2.65 cts. for flange, 2.6 to 2.8 cts. for firebox. Pittsburg: beams, 2 to 2.1 cts.; channels, 2 to 2.1 cts.; angles, 1.7 to 1.9 cts.; tees, 2.1 to 2.2 cts.; Z bars, 1.9 cts.; universal mill plates, 1.7 to 1.8 cts.; sheared steel bridge plates, 2.1 to 2.25 cts.; refined bars, 1.7 cts. for iron and steel; steel plates, 1.65 to 1.7 cts. for tank, 1.95 to 2.15 cts. for shell, 2 to 2.05 cts. for flange, 3.4 to 3.45 cts. for firebox, 1.9 to 2 cts. for bridge. Chicago: beams, 2.17 to 2.25 cts.; channels, 2.27 to 2.5 cts.; angles, 1.9 to 2 cts.; tees, 2.2 to 2.3 cts.; universal plates, 1.95 to 2.1 cts.; steel plates (at mill), 2 to 2.1 cts. for tank, 2.12 to 2.25 cts. for shell, 2.25 to 2.75 cts. for flange, 2.7 to 2.8 cts. for firebox.